THE LEHIGH QUARTERLY.

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THE LEHIGH QUARTERLY.

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THE

LEHIGH QUARTERLY.

FOUNDED BY THE CLASS OF 1891.

Vol. I. JUNE, 1891. No. 3.

READING AND INDEXING.

BY IRA O. BAKER, PROFESSOR OF CIVIL ENGINEERING IN THE UNIVERSITY OF ILLINOIS.

READING.

"Reading makes a full man." That which Bacon meant by "full" can be attained only by wide and thorough reading. But it is not necessary here to enter upon any argument to prove the importance of reading as an element of an education. I desire only to remind you that it is by reading that we avail ourselves of the thoughts and experiences of others. If it were necessary for the engineer to accumulate his professional knowledge by individual experience, or if he were compelled to cross the ocean to obtain by personal observation facts which he may get in an hour's reading, he would need the years of Methuselah, and then die a very ignorant, and consequently a poor, engineer. Yet there are men who claim to be engineers, or desire to become such, who seem not to appreciate either the value of the information gained, or the invigorating and stimulating effect of regular and systematic professional reading. No genius, no originality, no inventive power can supply a deficiency in this respect.

Nor is it necessary to discuss here what the student should read—that is done in connection with the class-room work in the various subjects. But I desire to emphasize the fact that

every student should regularly and carefully read one or more professional journals. As civil engineering students you are to be congratulated on the number and excellency of the publications devoted to your chosen profession. The current professional literature can not fill the place in an education occupied by carefully prepared and elaborate treatises, but the latter can not have that stimulating, invigorating quality possessed by a description of present practice and discussions relating thereto. The perusal of the pages of a good technical journal is the next best thing to personal practical experience or to acquaintance with men who possess such experience.

However, it is only when reading is properly done that it becomes of any considerable value. My experience leads me to believe that much of the reading that a student does, and for that matter some of what he calls study, is practically worthless. There are two objects in reading—recreation and information. Each has its proper place, but for present purposes we are interested only in the latter. When the object is information, the *reading should be performed deliberately and thoughtfully.* Young people, perhaps naturally enough, are continually tempted to read for amusement; and when they read for instruction and improvement they are very likely to employ the method used in reading only for amusement. Many even employ the same methods in studying. Simply scanning the lines with the eye or pronouncing the words with the tongue is not reading in the highest and truest sense.

If it is a book you are about to begin, examine the title page and see who wrote the book. Do you know anything of the author? Where does he live? What have you heard of this book? Why do you think of reading it? Read the preface to see what the author has to say of his own work, for the preface may contain some important limitation, or some valuable explanation. Notice the date of the publication—not of printing,—the former is usually at the end of the preface, the latter at the foot of the title page. Next turn to the table of contents and see what are the chief divisions of the subject, thus getting a knowledge of the general plan of the work. If after this examination the book is promising, turn to the part where some important point is dis-

cussed, or where some valuable thought professes to be expounded, and see how it is done. After a few such trials, decide whether the reading of the book will probably repay you. It may be too elementary, or too advanced; or the style may be obscure, or it may neglect important conditions and therefore not be reliable. If you decide to read it, carefully examine the table of contents to get the scope of the book well in hand. Now proceed to absorb the book. At the close of each sentence, ask yourself: "Do I understand that?" "Anything there that I ought to remember?" At the close of each paragraph ask the same questions, and mentally go back and make a summary of the whole paragraph.

Do not leave it until you have the substance of it in your mind. Do this for each successive paragraph. At the end of the chapter look back and see what the author tried to accomplish, and then determine whether he has done so. No small part of the time should be spent in reviewing, that is, in reflecting on what you have read. If the book is your own, mark with a pencil the more important statements to be further investigated, or some good illustration, or some particularly forcible sentences; in short, indicate by a mark the important parts of the book. (You can well afford to pay for a good book to obtain the right to thus mark it.) Also notice whether the argument is stated in good form, and whether the facts are presented in the best order.

This method of reading will be comparatively slow, but it will pay. It will compel you to *think* as you read, to judge, to discriminate, to sift out the wheat from the chaff. Right here is where many fail in what they consider study. They do not think as they read. Reading or studying is useless, unless you make the thought your own; and to do this it is necessary to think while you read, to stop at the end of each paragraph to think, and to think about what you have read even after you are done reading.

The above method of reading can be applied to newspapers and magazine articles as well as to books, except that the range of questions which you should be continually asking yourself is greater.

In closing this part of my subject, it may be well to mention that there is thorough reading and judicious skipping. Each has

its appropriate place, and there is no one so wise but that he will frequently do the one when he ought to do the other.

INDEXING.

In reading and in conversation, it often happens that we find information which is quite certain to be needed in the future. Unless some note is made of the place where each item may be found, much valuable information is certain to be entirely forgotten or at least can not be found when required, and in either case it is practically lost. How fortunate it would be if we had the power of keeping all that ever passes through our minds which is really worth keeping! Since we do not possess this power naturally, it is all the more desirable that we should employ the best artificial substitute. The universality of memorandum books indicates a general need of some form of supplemental memory.

What shall it be? In general it must be some device that requires but little labor or time to keep up, and that can be easily and quickly consulted. The last specification demands that the material shall be thoroughly classified. Some one has said that the best education is not knowing so many things, but ability to find anything wanted. The only valuable knowledge is the available. To be available it must be so classed that it can be found at once.

The precise form of the device to be employed depends somewhat upon the nature of the material to be preserved. Several methods of preserving scraps, notes, memoranda, etc., will be briefly described and compared.

SCRAP-BOOK AND MEMORANDUM-BOOK SYSTEM.—The most common and the least valuable method is to paste newspaper clippings into a scrap-book, and to record other information in a memorandum-book. Concerning this method of preserving facts, notice that the time and labor required to put newspaper cuttings into a scrap-book and then to index them, is so great that few will have the time or patience to keep it up. Second, if notes and memoranda are recorded in a book, when the number of entries become considerable it will be nearly impossible to find what is wanted, because it is practically impossible to make and maintain

a full index to them. Further, the record book soon contains a large amount of obsolete and useless material, which it is desirable to get rid of, but which practically can not be done.

The pasting of the scraps and writing the notes upon loose sheets to be afterwards classified and bound is a slight improvement on the form described above; but is still, in the main, open to both of the objections as above.

ENVELOPE SYSTEM.—The next best method of preserving scraps, notes, and memoranda is by what is generally known as the envelope system. To use this system a number of envelopes, of any size or form to suit the user, are provided; and each envelope is marked with the subject of its contents. For example, one envelope may be labeled Bridges, another Railroads, a third Municipal Engineering. Any scraps or notes are preserved by simply slipping them into the envelope. When one envelope gets too full, use a second one, or better, subdivide the subject. For example, if the Municipal Engineering envelope gets too full mark one MUNICIPAL ENGINEERING—*Water Supply*, a second MUNICIPAL ENGINEERING—*Streets and Pavements*, and a third MUNICIPAL ENGINEERING—*Sewers and Sewage Disposal;* and classify the scrap notes accordingly. Any notes made of items that can not be clipped out, or any calculations, or any sketches, are made upon loose sheets of paper and filed in the proper envelope. Where a clipping or memorandum relates to two or more subjects, and can not readily be divided, it is filed under one heading, and a reference to it is entered on the sheet provided for references in the envelope devoted to the other subject.

The principal advantages of this system over the scrap-book and memorandum-book are: 1. No paste is used, so this greatest nuisance is escaped. The leaves never stick together, which is a decided recommendation. 2. Both sides of printed sheets are preserved. 3. Any item may be taken out, used, and returned safe and sound, which is a great convenience and quite out of the question in ordinary scrap-books. 4. When a better copy is found or a scrap becomes useless, it may be thrown out without injury to others. 5. The whole mass of scraps, notes, and memoranda is always indexed to date under subjects for instant refer-

ence. This is a very valuable feature. 6. This index can be made just as full as required by cross-references on separate written slips.

The envelopes may be classified alphabetically, and stored in a plain box or a series of pigeon holes made for the purpose. Although it is advertising an article that some one is trying to make money out of, I will mention that the Library Bureau Association, 32 Hawley Street, Boston, Mass., sells what is called a "Utility Scrap-Book," which consists of a series of twenty-six pages containing five pockets each, appropriately indexed and securely bound together. The pockets are about eight inches long and three deep. For a comparatively small number of references this is very valuable. Price, $2.00. The same firm also sells "Breed's Portfolio Scrap-Book," which is a series of fifty manilla pockets, nine by six inches, securely bound in book form. The pockets are all provided with tucks, so it is impossible for the clippings to fall out and get lost, even though the book should be dropped on the floor. This has all the advantages of the "Utility Scrap-Book" and can be placed on the shelf with the other books of the library. Price, $2.50. The same firm also sells the "Library Association Scrap-Book," which consists of one hundred manilla envelopes or pocket-books, arranged in a heavy case. A thin book index serves for analyses and extra cross references beyond those on the pockets. Price, $2.50.

CARD CATALOGUE SYSTEM.—The essential feature of this system is a number of cards upon each of which is written the reference or data to be preserved. At the top of each card a word or phrase is written which shows the contents of the card. These cards are then placed in a box or tray. A common envelope box does fairly well for this purpose, but boxes are made especially for the purpose which have a good many advantages over a simple pasteboard or wooden box. Cards of guaranteed uniformity in size and quality are furnished by the Library Bureau Association as above.

Clippings from newspapers, if not larger than one of the cards, are simply pasted on one. For clippings larger than the cards, ordinary envelopes of the same size of the cards are provided.

The clipping is folded and put in the envelope, and the index title is written in the same position on the outside of the envelope, as it is on the card. It will happen that on some subjects so much material will be collected that an ordinary envelope will not hold it all. To provide for such cases use larger envelopes and store them in a series of pigeon holes. The pigeon holes should all be numbered, and the titles of the subjects contained in them should be entered on a card with a reference to the number of the pigeon hole. The number of the pigeon hole should also be written on the envelope, pamphlet or other document contained in it so that it may be returned to its proper place. Pamphlets, catalogues, etc., may be numbered and stored on a shelf, a card containing the title and a brief summary of contents being placed in the card catalogue.

But to be of any value, the cards must be so classified that cards relating to any subject can be turned to immediately. All such information is useless unless it is available; and to be available, it must be classified so as to be found at once. There are two methods of classifying the cards—the dictionary system and the decimal system.

In the *dictionary classification*, each card is given a title which is descriptive of the information it contains, and the cards are classified alphabetically according to the index title. Let me illustrate this by an actual example. A few days ago, in reading a a book on chimney construction, I came across some data on the adhesion of mortar. The data seemed to be quite reliable, there is but little extant on that subject—which is an important one,—and one would probably not think of looking in that place for such data; therefore I made the following note on a card:

> Mortar, adhesion of, for a few data on, see Bancroft's "Chimney Construction," pp. 20-1.

This card is simply dropped into its proper place among the M's, and this bit of information is indexed. If the number of memoranda is great, it will take some time to find any given letter, and therefore it is well to have 26 cards of some other color, say red, about one-quarter of an inch wider than those on which the memoranda are written, having a letter of the alphabet on the upper edge of each. These cards serve to separate the different letters

from each other and greatly facilitate reference to the catalogue. The number of references may become so great that divisions by single letters of the alphabet alone will not be sufficient for convenience in finding what is sought. To provide for this, procure blue cards, of the same size as the red ones, having three index letters on them the same as the headings of a dictionary, so that the cards under each letter of the alphabet may again be subdivided as often as required for convenience.

In the *decimal classification*, the entire field of knowledge is divided into nine main classes and these are numbered by the digits 1 to 9. Cyclopedias, periodicals, etc., so general in character as to belong to *no* one of these classes are marked 0, and form a tenth class. Each class is separated into nine divisions, general works belonging to *no* division having 0 in place of the division number. Divisions are subdivided into nine sections, and the process may be repeated as often as necessary. For example, 526.98, stands for Topography, thus: the 5 stands for Natural Science, the 2 for Astronomy, the 6 for Geodesy, the 9 for Surveying, and the 8 for Topography. Similarly 628.47 means: the 6 Useful Arts, the 2 Engineering, the 8 Sanitary, the 4 Sanitation of towns, the 7 pavements; or briefly, 628.47 means the cleaning of pavements. With this system, each card is given a number, which is in fact a *brief* title, and the cards are arranged in the box or tray according to the number at the top of each. For example, the following card is fully indexed by simply numbering it 624.302.

> "According to a private letter from the engineer in charge, the cost per linear foot of Howe truss bridges on the Chicago branch of the A., T. & S. F. R. R., constructed in 1886, was as follows: *through spans*, 66 feet $21.45; 86 feet $23.20, 106 feet $27.45, 126 feet $28.50, 150 feet $32.46; *deck spans*, 66 feet $22.00, 106 feet $27.75."

The decimal classification has some advantages over the dictionary classification. 1. It is easier to write the number at the top of the card than to give, in words, an equally explicit index title. 2. The decimal classification is according to the nature of the subject and not according to the accidental initial letter. For example, a short time ago I received a friendship letter which contained the following information; and as it was very valuable, I put it upon a card:

On the Chicago branch of the A., T. & S. F. R. R. curves were valued at $10 per degree; rise and fall at $100 per foot; distance at $8 per foot.

With the decimal classification the card containing the above is fully indexed by numbering it 625.1. What title should it have in the dictionary classification? 4. By the use of the index referred to below one insures uniformity in classification—a very important matter—and knows just where to look when consulting the cards.

On the other hand, the *dictionary system* has one advantage over the decimal system. To use the latter one should have Dewey's Index, which costs $5. (For sale by the Library Bureau Association, as above.) Dewey's Index is arranged especially for librarians, and some of the subdivisions are not well arranged for the purpose here discussed. But the writer believes that the advantages of the decimal system greatly outweigh the disadvantages.

Without further considering the relative merits of decimal and dictionary systems of classification, let us compare briefly the relative merits of the card catalogue and the envelope system of preserving memoranda.

In beginning it is well to say that each has its advantages and its warm advocates. Possibly the system adapted to any particular case depends upon the form of the material to be preserved, *i. e.*, whether mostly clippings or mostly memoranda. The writer believes that the envelope system as explained above is simply one of the two features of the card catalogue, and that for most people and purposes it is the least valuable of the two. The disadvantage of the envelope system by itself is that the material is not *thoroughly* classified, since the contents of each envelope is a heterogeneous mass. With many persons the most of the data to be preserved consists of bits of information picked up here and there, or of reference to newspaper and magazine articles on certain subjects in which the person is interested. Obviously the card catalogue is better suited for the preservation of such matter than the envelope system.

On the other hand, there are some who apparently desire to preserve only clippings from papers, etc., and occasional memoranda. For such the envelope system seems to do very well. But

it is a mistake to cut up technical journals, for it is well known that the most careful indexer has frequent occasion to consult the indexes of such publications in search of information which he once thought would be of no use to him. The card catalogue permits the papers and periodicals to be bound and stored away for reference as called for by the memoranda on the cards or to be examined for information which is not indexed.

But notice that the card catalogue is useful in indexing and preserving various classes of information besides that discovered while reading. Any fact or data gained in private conversation or correspondence can be transferred to a card in a moment and be filed for future reference. Any sketch of new construction is easily preserved in the same way. Addresses are easily recorded and also easily found.

"It is easy to grow enthusiastic over the card catalogue. Its convenience is so great, the amount of work required is so little, that a person with even a moderate amount of time and industry will be able to do a great deal with it. A few cards can be carried in a pocket-book, and notes made at any time or place. To record such memoranda all that is needed is to drop the card into its proper place. It is then indexed, and will be preserved so that it can be found at any time. In fact this system is suited to the needs of any occupation or profession, and to any business or office, and may be universally applied, and is equally well suited for keeping a housewife's domestic receipts, a railroad engineer's notes and data, or a prime minister's memoranda on diplomatic affairs. It has the advantage of being suited to the smallest as well as the greatest affairs. A boy or a student may begin it with a cigar box and a few pieces of stiff paper cut to the size of a postal card, or the affairs of a great railroad or the accumulated affairs of a life time may be recorded in this way.

"It seems as though the time has come when it will be necessary to adopt some great and comprehensive system of indexing knowledge to make it available. The bulk of it is now so great and increasing with such fearful rapidity that it is beyond the power of a single mind or individual to make use even of that relating to a narrow specialty. What is there to prevent two persons from agreeing to duplicate and exchange their notes or cards?

The amount of data thus accumulated by each, supposing that they were equally industrious, would be thus doubled. If two persons could do this, why not twenty, two hundred, two thousand, which brings us face to face with an organization of persons interested in the same subjects, and who would agree to forward all useful notes, memoranda, etc., to a central repository, there to be carefully edited, then printed on cards, and distributed among the members."

A number of engineering societies are already doing this in a limited field. In the Journal of the Associated Engineering Societies there is each month a number of pages of references and brief summaries of the more important articles published in the engineering papers and periodicals. The entries in the monthly parts are arranged so that they may be clipped out and pasted on the cards of the card catalogue, or of course they may be copied on the cards. At the end of each year the monthly parts are reprinted in a single volume.

In conclusion I desire to impress upon you the fact that an immense amount of valuable information may be accumulated if once the habit is formed of making a note of whatever is likely to be of value. If you have not already begun, as I am glad to say many of you have, my earnest advice is to begin immediately and follow it up industriously and systematically.

THE EARLY DRAMA AT LEHIGH.

I can not now recall any recitation or lecture during my stay at Lehigh that was attended with greater regularity or more keenly enjoyed than were the Saturday night gatherings at Rennig's. The bill-of-fare of this popular resort at that time was not an elaborate one, indeed it consisted solely of oysters in and out of season. It was not, however, the oysters that gave the distinct individuality to the place, but rather the "trimmings" that were served with them. They consisted of three pieces of brown bread, a pot of mustard and a large slice of Swiss cheese. The cheese was laid on the bread and then covered with mustard. This we ate in about equal proportions, and if I did not relish my break-

fast on the following morning the effect at the time was such as the delights of the table have seldom afforded me. These meetings were of the most informal kind and were known for the distinctly college spirit displayed. All class feeling was dropped for the time, Freshmen and Sophomores joined in the same choruses and very late in the evening a Senior has been known to smile at a Freshman's joke.

So successful were the meetings that the students freqently invited their friends who were not in college—and the members of any theatrical company that happened to be playing in town on a Saturday night were always given an informal reception after the performance. On these occasions we sang the college songs, and any one who was capable of doing any kind of an "act" could depend on being called on during the evening. It was from these meetings then that the idea of a regular dramatic club was formed, and when names for the new club were in order there was none that seemed so appropriate to me as the "Mustard and Cheese." It has long been the custom to call college dramatic clubs after some peculiarly popular dish, and there was certainly none so typical to Lehigh as "Mustard and Cheese." Jacob Robeson objected strongly to this name and sarcastically remarked that we had better call it "Oysters and Shells," which was afterwards really seriously considered, but the "Mustard and Cheese" finally secured the verdict.

The first officers of the club were elected at a meeting held in the rooms of Mr. Robeson, in the early part of March, 1885. They were as follows: President, A. S. Reeves; Business Manager, C. E. Clapp; Musical Director, H. S. Haines; Stage Manager, C. B. Davis.

Exactly why these men should have been chosen for the offices it would be difficult to say. Mr. Reeves' reputation in college was unique, he was known as the best looking, best dressed, and most exclusive man in the University. His name gave a certain air of respectability to the club and hence he was offered, and accepted, the position of President, as he did everything else—gracefully. I can not now recall his having done anything else. Mr. Clapp had brought the Base-ball Club to a financial Waterloo, but we thought this experience might stand him in good stead as a theat-

rical manager. Mr. Haines was naturally chosen Musical Director, as he was the only member renting a piano for his personal use. The position of Stage Manager, after having been refused by several men, was finally offered to myself, my chief claim being that I had attended more variety shows that season than any other member.

The date of the first performance was fixed for April 10th, and with little more than a month to prepare we began rehearsals at once. The play chosen was one of Byron's burlesques, "Sir Dagobert and the Dragon." The first rehearsal, which took place at Rennig's, was not auspicious. We had no score for the songs and it was therefore necessary to select the airs of songs we already knew to suit the words in the book. Messrs. Howe and Haines succeeded in this to a great extent, but in most cases we dropped the songs of the play and introduced more or less appropriate ones of our own choosing from various comic operas and burlesques. The lines of the play were butchered in a like manner, so that on the occasion of our first production I doubt very much if Mr. Byron would have recognized anything but the title of his own play. The first performance was to be given in the old dining hall of the Sun Hotel. All the rehearsals after the first were held there, and as the hall had no piano our first duty was to hire one. The price was $12 a month held at our own risk or $15 if the risk of fire or accident was taken by the owner. As the club at that time had no money in its treasury we accepted the $12 bargain, and for three weeks I kept my head out of the window looking for a fire in the direction of the Sun Hotel. As the Bethlehem skies are always more or less lit up by the flames from the iron furnaces, my nervous system received a lasting shock.

I shall never forget the day of our first performance. The proceeds were to be devoted to the Tennis Association, whose members, although doing their share in the athletic world, were, as a body, extremely unpopular among the majority of the students, and the popular sentiment was strongly against encouraging any such "dude club." Notwithstanding this, every seat was sold several days before the performance, principally to the families and friends of the players. This fact alone was enough to pre-

vent failure, but the opposition on the part of the students had been so great, and we had had so many difficulties to overcome from the start, that few if any of us dared hope for a complete success. On the eventful day I was excused from recitations and went over to the hotel early in the morning. The hall was bitterly cold, but, weighed down with the importance of my position, I sat down and patiently waited for the night. Finally the costumes came and these kept me busy until the afternoon, which we spent in rehearsing. As the outcome of the performance was so uncertain we had arranged with the Glee Club, who had already given one successful concert, that they should assist us. Eight o'clock finally came and the Glee Club opened the performance to a crowded house. After they had finished their part the curtain was rung up on a skit called "Mary, the Child of Misfortune." As the first play ever produced by the "Mustard and Cheese," I give the cast:

Mary, . . .	H. S. Haines.
William, . . .	J. S. Robeson.
Sir Chauncey Dale, .	R. H. Davis.

It was a burlesque on the modern melodrama originally produced by Willie Edouin, but written for the occasion by Richard Harding Davis. It was extremely cleverly played, and the costumes and stage settings were particularly effective. When the curtain fell the actors were called out and the "Mustard and Cheese" had scored its first success. There was more Glee Club, and then came the event of the evening, "Sir Dagobert and the Dragon." There were thirteen people in the cast, and it would be difficult to say now who made the greatest personal successes. Every one was allowed to do just what he chose, so there was really no star part. If one of the chorus thought he could recite anything particularly well, he was given his chance, and if one of the ballet girls knew an especially good song she was given the centre of the stage, and the principals joined in the chorus. As my particular act, I had decided to give imitations of some well-known actors. A few of them I had seen, but most of them I had only read of in the papers or on the bill-boards. However, the audience were either as ignorant as myself or very lenient, so the imi-

tations went off very well. The critics made a few guesses at them in their papers the following day, but I believe none of them happened to select any one I had had in my mind at the time.

The performance passed off without a hitch, and was declared a success. The company afterwards gave themselves a very elaborate supper in the dining-room of the hotel, where every one drank every one else's health, and it was universally conceded that the Mustard and Cheese had come to stay.

I remember one rather funny incident of this performance, which was not on the programme. Skirt dancing was unknown at the time, and hence our ballet were dressed in short white tulle skirts and pink tights. Mr. George Neilson, one of the ballet, had seen fit to improve his figure by using a pair of long white stockings rolled tightly together, but while executing a particularly difficult and energetic step, the stockings unrolled, and one of them fell through his dress and hung from his waist under his skirt. The effect of the sudden collapse in the lady's figure and the long white stocking dangling by the side of the two long pink legs, created no little excitement in the audience.

The second performance given by the club was in December, 1885, and was again held in connection with the Glee Club. It was a very mediocre production of a stupid play called "A Silent Protector." Mr. Neilson, who was to hereafter be our leading lady, did what he could to save the piece, but although not an absolute failure it was far from a success.

On May 1st of the following year we gave our first performance without the assistance of any outside organizations, and scored another decided success. The plays produced were a short farce, and a musical comedy called "A Christmas Pantomime." I should like to say here for the benefit of any dramatic club that happens to be in search of a play that this is the best farce I have ever met with. It has several excellent comedy parts, bright dialogue, and, what is most essential to amateurs, is full of extremely funny situations. We produced this play on several occasions, usually changing the "curtain raiser."

Although a small part, I shall never forget the gentleman who originally played the Nephew. A Mr. Langdon was cast for the part and so successful was he at rehearsals that we rather imag-

ined he was down for a hit. And I think I may safely say that the idea was shared by Mr. Langdon. When he was to make his first entrance I was supposed to be writing at a desk with my back to the door. On the night of the performance I heard him come on and walk down the stage. I waited some time for his opening lines, and then fearing he had forgotten them turned to help him out, but to my horror he was nowhere to be seen. I was told afterwards that after walking to the footlights he had glared wildly at the audience for a few seconds and then crept softly out. It was a bad case of stage fright, and I don't think he recovered during the evening, so the part was regarded by the audience as one similar to the "Lone Fisherman" in Evangeline, who is on in every scene but doesn't speak a line during the entire piece.

I recall two other rather funny incidents which really made more pronounced hits than the best bits of acting we were capable of doing. It was during a farce in which I had to make love to the leading lady. We had arranged that I should kneel and the girl should then sit down and receive my addresses. It went very well until the lady sat down, when I was surprised to see her dress slowly begin to rise from the floor until I thought it would soon be over her head. It seemed the dress, which was a very elaborate one, had been made with bones and reeds, and not being used to this sort of thing, the boy who played the part had sat on one of the reeds and caused this sudden upheaval. On another occasion, when we were playing in Reading, I was on the stage with George Neilson, who was doing a girl's part. He had come late to the theatre, and having a very limited time in which to dress he had simply pulled his skirt on over his trousers. The hooks and eyes didn't seem to act kindly under, or rather over, these conditions, and it had made him rather nervous during the entire play. We were apparently getting on very well, however, when I heard a tough in the gallery laughing most immoderately. Neilson, who never lost his head, said to me under his breath, "Davis, there's something loose—I feel a draught." I was not kept in ignorance very long, for he suddenly grabbed his skirt, which was slowly slipping from him, and started to walk sideways to the door, still keeping up the dialogue. He had almost reached the door, when with great force he ran into a heavy chair,

over which he turned a complete somersault, landing him on his head, his skirt on the floor, and his trousered legs kicking wildly in the air.

In October, 1886, we produced the Christmas Pantomime for the last time and I believe this was the last performance in which any of the original members appeared.

Soon after this I regretfully resigned my position of president and manager of the club and left the University. Since that time the club has given a number of successful productions, and I am sure those who took part in these latter plays enjoyed their success no more keenly than the old members who only read of them.

In a general way, I should say the success of the "Mustard and Cheese" was due to several causes. Firstly, to the pride every man took in the club and in making a success out of what we were assured on every hand meant failure. Secondly, to several men who wanted to act but who didn't know how, and several more who knew how but who didn't want to. Thirdly, to our advisory committee, the chairman of which was Mr. Jacob Robeson. Mr. Robeson in his official capacity was the most objectionable individual I have ever known. He objected to everything from Shakespeare's English to the manner in which the bass viol rosined his bow. I am happy, however, to have this opportunity to thank him for the great good he did the club.

In all dramatic clubs there is a power behind the throne, some one who does most of the work and receives in return but little thanks. In this respect the "Mustard and Cheese" was no exception. Occasionally his name appeared upon the programme as an executive or as player of some small part, but whether the difficulty was with a member of the company or a scene shifter I always turned to him and I never knew his quiet, earnest manner to fail in gaining the result I desired. His work in the "Mustard and Cheese" was but the part he played in the college life; but little noticed, the effect was keenly felt—an effect so strong that I doubt if it is still not manifest in the life of that great University. If he were alive, it should be he, not I, who would write of the early struggles of this club. But a few years since he left this world for a much better one. I am sure of this, for any world is the better for having little Harry Haines. C. BELMONT DAVIS.

PLUMBING A SHAFT.

The general practice of mine surveying in the Anthracite coal regions differs very little from the general practice of outside surveying, except that the peculiar difficulties, increasing the liability to error, and the prime importance of absolute accuracy necessitate the employment of methods comparing favorably with any in the country, the Coast and Geodetic Survey excepted. Among the difficulties peculiar to mining, the most puzzling has been to carry underground the meridian upon which the outside surveys are run, when the only connection with the surface is by a vertical shaft. It is obviously of the greatest importance that the mapping of underground workings be invariably accurate. The limits of a coal property are located on the surface, and the mine workings must not exceed these limits. The actual safety of the mines also requires accuracy, as the recent disaster at Jeanesville warns us. When the outlets of the mine are by shafts, the whole inside survey hinges upon the exact agreement of our inside and outside meridian, the method of determining which we will now briefly sketch.

There are two methods employed. In the first we make use of a special transit so constructed that when the telescope is plunged at a heavy angle the line of sight is not obstructed. By setting this instrument on one side of the shaft at the surface, a sight can be taken on the opposite side at the foot. This method has not proved successful, not only owing to the difficulty in taking the sight, but also from the fact that even the best mining transits of this description can not be adjusted with the necessary accuracy. Suppose the shaft five hundred feet deep, and that we can obtain a horizontal sight of eight feet. With a line of such length we could not prevent an error of perhaps an eighth of an inch, an amount ruinous to the accuracy of our survey. An error of one-eighth of an inch in eight feet would amount in a mile to an error of seven feet.

The other method almost invariably used is "plumbing" the shaft or carrying the course down by means of plumb-lines consisting of copper wires with heavy suspended bobs. In theory this method is as simple as it is laborious in practice, and demands the utmost care and patience. There are three principal methods of procedure. The first two depend upon the existence of two openings from the mine. The Pennsylvania mine laws require that every mine have at least two separate outlets. It may happen, however, that these two openings are so widely separated and the passages between them so blocked that they can not be used, for our purposes, in connection with each other. Our first and simplest method when we can make use of two shafts is to suspend one plumb-line in each shaft. Then we run a surface survey, with our outside meridian as a base, from one wire to the other, calculating the course and distance between the wires. Then starting underground we assume a meridian, run a survey between the wires, calculating as before the course and distance upon our assumed basis. The difference between the two courses thus determined is the error of our assumed meridian. To avoid the possibility of error, we should run both surveys back to the starting point, effecting in each case an exact closure.

In the second and better method, two plumb-lines are suspended in the first shaft. By thus running down on any convenient course we determine at once the exact meridian. The underground surveys are then run at once upon the true meridian, and the accuracy of work is checked, as before, by the third wire in the second shaft.

When we can not connect our survey underground with the second shaft, we must work with the greatest care, as we have not the second shaft by which to "tie up" our work. The usual method of proceeding is to run down two wires as in our second method. In this the plumbing should be, and usually is, repeated, the agreement of the two results serving as check upon the accuracy. Another method is sometimes used, which, though more tedious, allows a tie to be effected. This method requires two transits, and it is better to have two separate parties working at the same time. In this case three wires, *a*, *b*, and *c*, are run down the shaft; the course *a b* being in line with one transit,

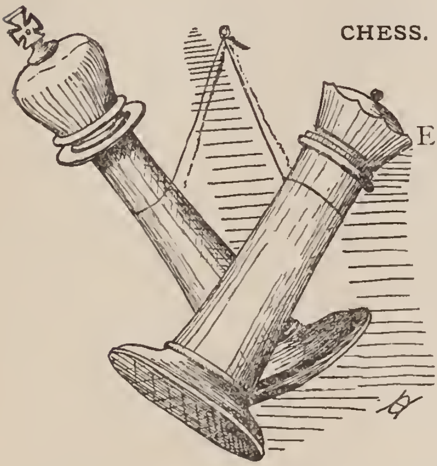
the course *ac* being in line with the other. The two parties work separately in ascertaining the underground meridian, and a tie can be effected, thus checking the accuracy of their work.

In plumbing a shaft there are two special precautions to be noticed. The shortness of the available line of sight, which averages about eight feet, makes it essential that in each case the line of collimation cut the wires exactly in the middle. The second difficulty is in steadying the plumb-lines, owing to their length, and exposure to dripping water and especially the eddying air currents in the shaft which is used as an intake for ventilation.

Let us now briefly follow the steps in the process, assuming that we have only one shaft and are running two wires down the shaft. Two cleats are first firmly spiked on each side of one of the hoistways, and by means of a plumb-line two nails with notched heads are set exactly in line with the transit previously set on any convenient course. This course is generally read by two persons to balance any personal error. The copper wires, usually No. 17 gauge, are then suspended and paid out as the cage is lowered, care being taken to avoid catching on the side. At the foot two linked keyrings are attached to the wire nearer the instrument at about its elevation, so that the sight upon the farther wire may not be obstructed. The bobs are then suspended in water, or, better, crude black oil. If oil be used, a galvanized iron can with adjustable cover is used to prevent the entrance of water and loss of oil. The bob used is generally of the ordinary form. The Lehigh Valley Company, however, use an improved form. It consists of a vertical core 12 inches high with 8 radiating flanges, 9 inches high by 3 inches wide, of one-quarter-inch metal, protected by a circular disk at the bottom acting as a web. This bob weighs 20 pounds and has a surface area of approximately 630 square inches. An ordinary bob of equal weight would have a surface area of about 90 square inches. The form of this bob is also peculiarly adapted to resist motion in any direction. By the use of this form of plumb-bob the time of settling under favorable conditions in an ordinarily dry shaft, five hundred feet deep, is reduced from five or six hours to about one hour.

When the wires are perfectly rigid the instrument is placed at a convenient distance approximately in line. It is then shifted till the line of collimation cuts both wires exactly in the middle. This work is also checked by a second person. The course being thus determined, the difference in elevation is taken between the tops of two corresponding rails, and the height of the instrument then determined as is always done in mine survey practice, by sighting on the rail, measuring the distance on the angle, noting the vertical angle, and calculating afterwards in the office the horizontal and vertical distances.

CHESS.



VERY little that is original can be written on a subject that is older than the very art of writing, and which has been thoroughly investigated in all its branches by the greatest minds of the past and of the present. No other game, of skill or of chance, has so voluminous a literature. In the Middle Ages it was the favorite pastime of nobles and religious, who had a monopoly of the education of the times. They studied it deeply, and when the art of printing was invented works on chess were among the first published. However, it was not always confined to the educated and highborn. It has found in all ages devotees equally ardent and successful among the high and low, the educated and the ignorant. The wit and the blockhead have both become adepts and the latter is sometimes the more skilful of the two. It seems to recognize a special kind of genius, as different from the genius of the great mathematician or from that of the great

physicist as these two are from each other. Deschapelles, by whose soul the French player swears, was a soldier. Ruy Lopez, the inventor of an attack that has stood the test of centuries and is still universally played, was a Spanish monk. Among the best players recorded in the history of the game we find Charlemagne, Richard Cœur de Lion, Voltaire and Rousseau in the company of Philidor the musician, Ercole del Rio and Lolli, the Modenese jurists, and the higher in station were the weaker at chess.

The game seems to have been introduced into Europe by the Arabs, and it probably originated in India, but we have little authentic history of it before the time of the Crusades. The stories of its origin are many and varied, but the most frequently told is this: A very tyrannical monarch of India, becoming weary of all the royal amusements which were customary at that time, ordered his prime minister, a wise man and devoted to his country's good, to provide for him some other amusement which should be more diverting than any of the existing. After a proper length of time spent in hard thinking, the minister presented to his royal master the game of chess, wherein the king, while playing a most necessary part, depends for his existence and that of his state on the aid of his nobles and soldiers. The king soon learned to love the game and to apply its moral to the governing of his kingdom, and, in gratitude to the minister, promised to give him whatever he should ask, except only his crown. The minister asked that for the first square on the board he be given a certain small area of land, and for each subsequent square double the amount of the preceding one. The king readily promised this, and the minister then proved that all his kingdom contained but a small fraction of the required area. Why the latter part of the story is tacked on we can not imagine, unless it be to magnify the king's impression of the greatness of the game. It conclusively demonstrated to the king, however, that he was not the state, and that he did not own the earth. Most players look on this story as merely a pretty legend and believe the game to have been the product of several strong minds.

The first authentic records of the game in Europe are found about the time of the Crusades, but, if we believe in its authen-

ticity, we have a letter from Cardinal Damianus, bishop of Ostia, in 1061, in which he speaks of imposing a penance upon a bishop for playing chess. Such punishments were by no means rare. The statutes of the Church of Elna provide that "clerks playing at dice or chess shall be *ipso facto* excommunicated." St. Louis, king of France, fined all chess-players, and John Huss when in prison deplored his having played at chess, whereby he had lost time and risked being subject to violent passions. Yet in later times we read of all these churchmen and nobles among the most enthusiastic and skilful players. Since the time of its introduction into Europe the game has undergone many changes, most of which have tended toward its improvement, making it more scientific and more interesting, and consequently more popular. But in the present time we seem to have arrived at the limit of improvement. Chess is intricate enough for most of us as it stands, and the increase of the power of any one of the pieces, or the addition of an extra man, would make of it more than a recreation. Let us see how, by successive gradual changes, we have arrived at our modern game. The king, except for castling, has always moved as at present. He has been the most enduring figure in the game, the center about which all the other pieces have grouped themselves, fighting and even dying to save him from harm; changing in power, rank, and position, yet always remaining devoted to their king. In direct opposition to the firmness of the king's position, we find that the queen has been the most changed. From the obscure counsellor, moving but one square diagonally, weaker than the weakest foot-soldier, she first changed her sex and then arose by degrees to the lofty station she now holds, the active leader of the king's forces, most powerful in attack or defense. Her period of most rapid transition was during the fifteenth century. Next to the queen in unstability comes our bishop, than which no other piece represents so many different characters in different countries. In Persia he is an elephant; in Germany, a runner; in Italy, a standard bearer; and the French have dubbed him "the Fool." He formerly moved but two squares each time and had no power over intermediate squares. Like the knight, he could jump over obstacles but never capture them, and thus two opposing bishops, even though on the same color, could never capture each other. The

pawn, rook and knight seem to have always had their present moves. In the sixteenth century the rule was made which allows the pawn two squares on its first move. The boards before the thirteenth century were all the same color, the squares being marked by lines.

The history of the game as it is now played begins about the end of the fifteenth century in France, whence it spread into Spain and Italy. The latest improvement, castling, was introduced in 1561, in the time of Ruy Lopez, and his book treats of both the old and the new methods. In 1562 and 1575, when the glory of the Italian and Spanish masters was at its zenith, Giovanni Leonardo da Cutri and Paolo Boi visited Spain and defeated their two antagonists there, giving us the first of those international matches of which the present century has been so prolific. The seventeenth century produced several writers and analysts, but few good players, of whom Greco, the Calabrian, was easily the champion. The next century, however, has given us many sound analysts and expert players. Of these the best was undoubtedly André Danican Philidor, the Parisian, who, in his boyhood, had played at the Café de la Regence, the center of the French chess circles from his time up to the present. For many years his Analyse des Echecs was regarded as the best authority, and even now it is much used by writers on the openings. He made a tour of Europe, but failed to meet the three players most worthy of him, del Rio, Lolli, and Ponziani, three strong players of Modena; but he defeated the German Allgaier, the sponsor to a very brilliant variation of the king's gambit. On the death of Philidor another Frenchman rose to first place. Deschapelles, of whom I speak, was lacking in much of the theory of sound play, but he possessed such a genius for chess as placed him at the head of all living players.

About the time of Deschapelles many attempts were made to change the game. Marinelli, a Neapolitan, invented a three-handed game; several schemes were proposed for increasing the number of pieces; and the ardent French republicans tried to banish the monarchial feature of the game by re-naming the royal pieces. But none of these changes were universally adopted and they gradually died out. Yet reforms have been tried even in

our own times. "Chancellor chess" is the invention of a Missourian, in which he uses a ninth piece, the chancellor, combining the moves of the rook and knight as the queen combines those of the rook and bishop. "Chancellor chess," three-handed chess, and four-handed, are occasionally played, but only as a recreation from the tedium of the true game, and never with the earnestness which characterizes the latter. Before we leave the past century we should say something of the great chess automaton, a machine which sorely puzzled our grandfathers, and is still a source of wonder and admiration to ourselves. It was invented in 1769 by a German, Wolfgang Kempel, and after it had made a tour of Germany it was bought by Frederick the Great. He learned its secret and then ceased to care for it, and it was allowed to fall to pieces from disuse.

When the death of Deschapelles left vacant the throne of chess, his pupil, La Bourdonnais, succeeded him. He attained a much higher degree of skill than his master had ever possessed, and defeated the English champion, Macdonnell, in four of five hotly contested matches. The records of their games have been preserved, and furnish to the learner most excellent examples of sound and brilliant play. He died in the early part of the present century, and then a match was played between Staunton of England and St. Amant of France, resulting in a great victory for the former. For some time the championship remained with England, till Herr Anderssen, a professor in the University at Berlin, defeated Staunton. The German in his turn had to strike his flag to the great Morphy. Until 1857 the interest in chess in our country was hardly perceptible. But in that year the New York City Chess Club gathered together all the players in the country and held a tournament in New York, with the surprising result that Mr. Paul Morphy, a young lawyer from New Orleans, won first place without the loss of a single game. He had been predicted the winner, but his surprising score was a revelation to every one. Soon after, the New Orleans Club sent him to Europe to play with the masters in the old country for the championship of the world. He played a few weeks in England and was generally well treated by the members of the clubs there, but Mr. Staunton successfully avoided playing a match with him. From

London he went to Paris and defeated easily the best French players at the Café de la Regence, as well as Herr Anderssen, who came to Paris to meet him. He returned to New Orleans and from that city edited a chess column in the New York *Ledger* for some time, and died, a comparatively young man, in an insane asylum. Then ensued a struggle for the championship, which fell to the winner of the great London tournament, Mr. Zuckertort, from Germany, but his claim was disputed by many claimants. He held it a short two years, when, in 1886, Mr. Steinitz, then a German but now a naturalized American, defeated him in a celebrated match. The winner of the first ten games was to be awarded the match and the final score was Steinitz 10, Zuckertort 6, and several draws. The games are models of brilliancy and sound judgment, and the match one of the most exciting ever played. The matches that have been played since between Messrs. Steinitz and Gunsberg, and Steinitz and Tschigorin, have only strengthened the position of the American. For second place there are many claimants. England gives us Gunsberg and Blackburn; Russia, Tschigorin and Alepin; Tarrasch is the German champion and Weiss, the Austrian; Cuba boasts of her Golmayo and Carvajal, and the Mexican consul at Cuba, Sr. Vasquez, is quite strong. Americans put in second place Mr. Mackenzie, of the Manhattan Chess Club, (of which Steinitz is also a member,) while the Kentuckian, Showalter, and the Baltimorean, Pollock, former champion of Ireland, are hard to beat.

In the beginning of the nineteenth century a season of popularity began for chess in Europe which has continued and increased, and in this country the news of young Morphy's triumphs abroad aroused all the ardor of the older players and increased the membership of all of our clubs. New clubs, too, were formed in all our cities, and the wish of Ben Franklin that all young Americans should learn and love the game was near to being realized. It was not only a momentary spasm of excitement, for these clubs have continued to grow in number and membership, and to-day the Franklin Club, of Philadelphia, and the Manhattan, of New York, are among the foremost in the world, and Boston, Baltimore, Washington, New Orleans and St. Louis have all flourishing and powerful organizations, of which New Orleans is

by far the largest in America. Our colleges have formed chess clubs which, like most college clubs, have their prosperous and weak seasons, but through all discouragements they have persevered in the cultivation of a taste and an ability for chess-playing which has placed most of them at this day on a very secure footing. Columbia College to-day has a club that might compete with any clubs in the United States, saving perhaps New York, Philadelphia, or Boston. The College of the City of New York is extremely strong, while Princeton, Yale, Harvard, Cornell, Lafayette, Lehigh, and many of our southern and western schools have very fair organizations indeed.

To no other cause can we assign the sudden revival of chess at the beginning of the nineteenth century than to the state of perfection to which it had been brought by the efforts of the masters of the two centuries previous. In the olden days it was played as a mere useless pastime, fit only for idle men. Great proficiency was never attained and seldom sought after with much zeal. It had no universally fixed laws, and proficiency in the Italian game did not necessitate equal skill in the Russian. But now all that is changed. One may be sure that if he be an expert in England or America he will be among the first-rates in any other Christian country. Our Steinitz is the champion of the world, not only of New York State or of America. Besides, we can not help improving if we would; we have all the researches of Philidor and his contemporaries as a basis for our investigations, while they had but their own power of analysis on which to depend. We have examples of the splendid play of Macdonnell and La Bourdonnais, Morphy, Staunton, Anderssen and Steinitz, collected and published in convenient form for reference or study. The learner is confronted rather with the question of what to study than where he is to obtain a text-book. He has Angel and others less modern for learning the rudimentary principles of good play, and in Cook and Gossip he finds the almost infinite variety of openings with which most amateurs are familiar, and which represent in a condensed form the fruits of the voyages of the old explorers into that unknown land of mystery and of pleasures. The whist-player is limited to his Pole, and the billiard-player finds it hard to get a standard book on the game, but the chess-player's wants

are easily filled from the very newspapers that he reads every Sunday morning. Besides these, there are in America two well established chess monthlies, and even more in Europe. A list of the chess literature of the past fifty years would astonish one who is uninitiated and furnish abundant proof of the possibilities of chess for amusing and instructing. Poets have sung of it, artists have drawn inspiration from it, analysts have taught it, idlers have been amused by it, and moralists have drawn from the game of chess lessons for our guidance in the more practical world, where still we find pawns and knights and kings struggling against each other in the brave fight for life. D. A. USINA.

NITROGLYCERINE AND EXPLOSIVES CONTAINING IT.

Until a comparatively recent time, gunpowder was the only explosive of any practical importance and was considered to be adapted to both industrial and military use. The progress of the science of high explosives has displaced it from its lofty and unique position, but even yet it is by no means superseded, nor, on account of its adaptability to so many uses, is it likely to be. Mr. Nobel, in his work on Modern Blasting Agents, tells of its various properties in the following forcible manner: "In a mine it is used to blast without propelling, in a gun to propel without blasting, in a shell it serves both purposes, and in a fuse it burns quite slowly without exploding. Its pressure varies from 1 ounce (approximately) in the case of a fuse to 85,000 pounds per square inch in a shell. But like a servant of all work, it lacks perfectness in each department, and modern science armed with better tools is gradually encroaching on its old domains." The discovery of gun cotton in 1846 was the beginning of a new epoch in explosive science. This new agent was eagerly taken up by the European governments, but was abandoned after 20 years of severe testing, the failure being due to imperfect manufacturing, especially in the washing of the finished product and in a lack of knowledge as to its chemical constitution. The next year, 1847, was noted for the

discovery of nitroglycerine. The trials made with nitroglycerine were fully as disastrous and unsatisfactory as its predecessor had been and the numerous fearful explosions which occurred almost entirely discouraged its use, but, thanks to the patient, courageous efforts of Mr. Alfred Nobel, it was put under control. He proved that the compound was perfectly stable and easily and safely exploded by the application of the principles of detonation. The real era of nitroglycerine began in 1864, when a charge was set off by means of a minute portion of gunpowder. Ever since it has held the first place among high explosives, and though innumerable new compounds of widely different chemical natures have been invented, all are inferior either in safety, force or economy to nitroglycerine.

Let us next turn our attention to a few theoretical considerations on explosives as a class.

An explosive is any solid or liquid substance which, on the application of heat or a shock, very rapidly becomes converted, wholly or partially, into the gaseous state with the evolution of heat. Detonation has been defined as the almost instantaneous resolution of an explosive compound into other forms of matter, chiefly permanent gases occupying many times the original bulk of the explosive, and hence exerting enormous pressure. The fulminates are the general type of detonators. Explosives are divided into two classes, high and low. The former are more powerful and their explosion is effected by detonation and consequently very rapid, and is similar to a blow crushing the surrounding objects into a great number of small pieces. The low explosives are usually set off by simple ignition and this explosion proceeds, progressing by combustion. These are slower and their action more of a heaving one. Nitroglycerine is the type of the high class and gunpowder of the low class of explosives.

Nitroglycerine is manufactured by injecting glycerine under pressure into a mixture of nitric and sulphuric acids, both concentrated. The reaction involved is

$$C_3H_5(OH)_3 + 3HNO_3 = C_3H_5(ONO_2)_3 + 3H_2O.$$

The proportions used are one of glycerine to one of nitric acid, and from two to four parts of sulphuric acid. The mixture is contained in a large wooden vessel lined with lead, from which

the product is allowed to run into a large tank called the "precipitating tank," which is placed at a lower level and holds several tons of cold water. The mixing of the acid and glycerine is done by machine power and can be perfectly controlled, so that neither speed nor quantity can be exceeded. If the action should become too violent, the charge is quickly run into water and the action thus stopped by dilution. After the water, by diluting the concentrated acids, has allowed the nitroglycerine to separate, it is run into a smaller tank and washed completely with water, which enters at the bottom and is continually drawn off from the top. At the factory near Bradford, Pa., the washing is finished by means of a weak solution of sodium carbonate, and then as a final safeguard a little magnesia is introduced with the finished product. At Nobel's works the washing is done by blowing air through the mixture contained in the washing tanks. The operation is exceedingly dangerous and requires great care and special precaution, for nitroglycerine, as such and unmixed with any inert substance, may explode with frightful violence on even the slightest percussion.

Nitroglycerine, or as it is sometimes called Propenyl Trinitrate, or Trinitrin, is almost insoluble in water, but dissolves in alcohol and ether, being more soluble in the latter. It is a dense, oily liquid, of a pale brown color and sweet, pungent taste, producing when tasted acute headache, nausea and vomiting. Its specific gravity is 1.6. Nitroglycerine is not very easily inflammable. It burns on ignition without explosion. When dropped on a tolerably hot plate it quickly evaporates, but if the temperature be raised to 257° C. a violent explosion takes place, the violence of the action decreasing as the temperature rises. At a red heat the nitroglycerine assumes the spheroidal state and burns without explosion. It solidifies at 4.5° C. and in the frozen state is less dangerous than when liquid. If nitroglycerine is pure it can be kept for an indefinite length of time, but if the washing were not complete and small amounts of acid were still present, a gradual decomposition sets in with the formation of oxalic acid, glyceric acid and some other products. The chemical change which takes place during explosion is represented by the equation $2\ C_3\ H_5\ (ONO_2)_3 = 6\ CO_2 + 5\ H_2O + 3\ N_o + O$.

On account of the large number of frightful accidents which took place in handling this explosive it was denied transportation and had to be manufactured on the spot at which it was to be used. To overcome this inconvenience Mr. Alfred Nobel invented his "methylated explosive oil." This was a solution of nitroglycerine in ordinary methylated spirit, and when in this condition there was no danger of an explosion by percussion. When it was desired to use the nitroglycerine the alcoholic spirit was separated by dilution with a large volume of water. Nobel never intended that his methylated explosive oil should come into general use, but merely as an expedient till the invention of absorbed or "solidified nitroglycerine," which had been invented some time before, should become perfected and safely put on the market as an article of commerce. A similar compound is still made. The factory at Bradford still makes a compound similar to the one used by Nobel. They dissolve nitroglycerine in wood spirit using just enough for solution, and sell the liquid under the name of Americanite.

In 1867, Nobel succeeded in overcoming the inconvenience which attended the use of a liquid explosive by absorbing the nitroglycerine in kieselguhr. This is a very finely divided silicious earth and consists of the scales of distinct diatomacæ. Many other substances have been proposed as an absorbent for nitroglycerine, but kieselguhr is peculiarly adapted to that end, as it is capable of absorbing four times its weight of the oily liquid without becoming wet or pasty, and will resist a greater degree of pressure without parting with the liquid than any other substance.

No. 1 dynamite as manufactured by the Ardeer factory contains seventy-five parts by weight of nitroglycerine absorbed in twenty-five parts of kieselguhr. The mixture is made in leaden vessels provided with wooden beaters or stirrers. The dynamite is then made up into cartridges provided with a detonating fuse. These are very safe and convenient, are unacted on by water, and owing to the softness of the dynamite are not exploded by an accidental shock. Since it was first firmly established, it has commanded a wonderful sale, and yet has never caused disastrous accidents either in storage or transportation, such as those so often heard of in the case of gunpowder; in fact, with the exception of

the gelatinous compounds which will be referred to later, no other explosive is equal to it in point of safety. In comparison with blasting powder its use occasions considerable saving of time, tools, fuse, and labor, as it requires fewer and smaller bore holes and with an ordinary degree of care there is no excuse for accident. Rocks may be fractured even without boring by simply exploding a cartridge or two placed on the surface and covered with sand or clay. This, of course, requires a larger amount of explosive than when a short hole is bored.

Dynamite No. 2. This consists of forty parts of nitroglycerine with usually forty parts sodium nitrate, six of rosin, six of sulphur and eight of infusorial earth. These latter constitute the absorbent or what is technically known as the "dope." The theory of this compound is that the power may be very greatly increased by replacing the inert kieselguhr by an explosive of a lower order than nitroglycerine that will at the same time be an absorbent. Many of the authorities on explosives did not agree with this and thought that nitroglycerine being a detonating explosive of the highest order would exert its force before its more inert neighbors were completely ignited. Mowbray claimsthat "it is like quickening the speed of an electric current by coupling it to the velocity of a locomotive." Still it is a fact, that these salts do add very materially to the strength of the explosive, and the above deductions, though coinciding perfectly with theory, are nevertheless erroneous. One notices from the composition of dynamite No. 2, that it is essentially a mixture of nitroglycerine and gunpowder. With regard to the explosion of such a mixture Professor Charles F. Chandler of Columbia College has said that where gunpowder explodes in the ordinary way the explosion is slow and progressive, and produces a temperature much lower than nitroglycerine, but when the gunpowder is exploded by nitroglycerine its explosion becomes instantaneous, it becomes detonative and occurs at a much higher temperature, produces a larger volume of gas and consequently develops a much greater force than when exploded alone. Consequently the force developed by the explosion of a mixture of gunpowder and nitroglycerine and gunpowder when detonated, which last force is greater than when exploded alone. In order to test the

question, whether explosive absorbents or dopes add to the disruptive force of nitroglycerine, the following experiments were made by Henry S. Drinker, of the Class of '72: A charge of 5 drachms of No. 2 dynamite when exploded in a mortar threw the ball contained therein 620 feet, and a charge of 48 grains of nitroglycerine, which was the amount contained in the above charge of dynamite, threw the ball 358 feet. These results show that a charge of nitroglycerine, when mixed with black powder, gives a power greatly exceeding the sum of the intensities generated by each separately. The increase in force, however, is entirely dependent on the nature of the explosive dope and the perfectness with which it is compounded.

GELATINOUS EXPLOSIVES.—These consist of mixtures of nitroglycerine and nitrocotton in various proportions. The latter is practically dissolved in the former, in which condition they are so intimately blended that it is almost impossible for the compound to liquify or the nitroglycerine to exude, either from the action of water or through lapse of time. The property of being practically unaffected by water is shown in the case of blasting gelatine which was immersed under water for seven years, and on removal was found to be in precisely the same condition with regard to its strength and susceptibility to detonation as before immersion in water. These gelatinous explosives exhibit the maximum of power in the minimum of bulk, which is a very great advantage, as a powerful explosive at a price proportionate to its power is much more economic than a low-priced but weaker compound. There are, however, exceptional cases where the peculiar nature of the work to be done requires a low explosive. The first and most powerful of this class is blasting gelatine. It contains 93 per cent. of nitroglycerine and 7 per cent. of a special quality of nitrocotton, which in explosion resolves itself into CO_2 H_2 O and N, there being just enough oxygen present to combine with the carbon and hydrogen, so that its composition may be looked upon as chemically perfect for the purpose.

Blasting gelatine is a tough, slightly elastic, semi-transparent substance which very greatly resembles ordinary gelatine. Its plasticity makes it very convenient in filling small holes, as it can

be tamped and squeezed by a wooden rod and made to fill the cavity completely. Blasting gelatine is even more insensible to shocks than dynamite, and hence it is necessary to employ for its detonation a stronger detonator than is used for dynamite cartridges. It has been adopted by the German, Austrian, Italian and British governments for submarine mining, and for coast and harbor defence, and also for use in the pneumatic gun invented by Capt. Zalinski, of the United States Army. The disruptive force is at least 50 per cent. greater than dynamite.

GELATINE DYNAMITE.—This consists of 80 per cent. of thinly gelatinized nitroglycerine with potass. nitrate and wood cellulose in certain proportions. This compound detonates much slower than either dynamite or nitroglycerine, and its action is more of a heaving one and consequently is adapted to the removal of rock which is desired to be obtained in large pieces. Besides being 30 or 40 per cent. more powerful than No. 1 dynamite it is also efficient in blasting hard or metalliferous rock. The *gases* or fumes evolved are less injurious than in the cases of dynamite; it is perfectly stable, and like blasting gelatine is equally non-sensitive to friction, detonation or atmospheric influences. It is unaffected by water and can be used for submarine blasting and mining. It is preëminently the explosive that should claim the attention of all mine owners, consumers, engineers and quarrymen. Owing to the fact that no flame follows the explosion of a charge of glycerine dynamite, it has been largely used in mines which may be highly charged with fire-damp. The cartridge is placed in a water-tight bag and is kept in position by means of tin supports, explosion being effected by a detonator set off by a current of electricity.

BORLAND AND REID'S CARBO-DYNAMITE.—This explosive consists of 90 parts of nitroglycerine absorbed by 10 parts of charcoal, with or without sodium or ammonium carbonate and added water. The qualities asserted for this explosive are, that a large amount of nitroglycerine can be taken up by a small amount of absorbent, that the nitroglycerine is not at all removed by soaking in water, that water may be added at once, thus lessening the danger in storage and transportation, and lastly the rapid and complete combustion of the absorbing material. The charcoal

used to absorb the nitroglycerine is made by charring cork and is lighter and more porous than ordinary charcoal. A comparative experiment showed that a quarter of an ounce of kieselguhr dynamite produced a cavity of 347c.c. in a lead block, while the same weight of carbo-dynamite produced one of 599c.c.

MEGANITE.—This compound compares very favorably with kieselguhr dynamite No. 1, and with gelatine dynamite. There are 3 grades of the explosive, designated as meganite No. 1, No. 2, No. 3, with the following compositions:

	Nitroglycerine.	United Cellulose from Wood.	United Cellulose from Vegetable Ingredients.	Added Powder.
Meganite No. 1.	60	10	10	20
" No. 2.	38	6	6	50
" No. 3.	7	9	9	75

The added powder for No. 1 was sodium nitrate; for No. 2 and No. 3, the powder was a mixture of 75 per cent. of sodium nitrate, 1 per cent. of sodium carbonate, and 24 per cent. of wood meal in the former and the same quantity of rye meal in the latter.

Among the older nitroglycerine compounds we have lithofracteur, the ammonia, colmia, Hercules and Horsley powder, dualine, seranine and dynamite No. 2. The colmia and Hercules powders are nothing but mealed gunpowder mixed with nitroglycerine. Seranine and Horsley powder are mixtures of potass. chlorate and nitroglycerine and are somewhat more dangerous and expensive than the above, besides being no stronger.

Dualine consists of ordinary sawdust or wood files and nitroglycerine.

Lithofracteur is another of the old explosives and one that has commanded a very extensive sale, which, however, was due more to the business ability of its manufacturers than to any very great intrinsic merits of its own. Its composition is a variable one. The manufacturers publish it as nitroglycerine 55 per cent., kieselguhr 21 per cent., Barium nitrate and sodium and carbonate or either of them 15 per cent., sulphur and manganese dioxide or either of them 3 per cent. An analysis made by Mr. Ulex in Hamburg showed its composition to be: nitroglycerine 70 per cent., barium nitrate 5 per cent., coal dust, 2 per cent., and infusorial earth

23 per cent. The compound is not as powerful as dynamite No. 1. The ammonia powder invented by Ohlson and Norbin is far stronger than lithofracteur, but its chief disadvantage is the hygroscopic nature of its chief ingredient, ammonium nitrate. It consists of 80 parts by weight of $NH_4 NO_3$, 6 of charcoal and 10-20 parts of nitroglycerine.

Judson Powder is a mixture of nitroglycerine and various salts, but it differs from all other nitroglycerine compounds in that the grains are coated with some combustible substance offering resistance to the absorption of water and nitroglycerine. The amount of nitroglycerine in this powder can be reduced to as low as 3 per cent. The Senior Chemists in their trip to Bradford visited a factory where the Nonpareil powder was made. It usually consists of 60 per cent. sodium nitrate, 20 per cent. wood pulp and 20 per cent. nitroglycerine, although the nitroglycerine runs sometimes as high as 45 to 50 per cent. with a corresponding decrease in the sodium nitrate used. The powder is very largely used in the oil regions and for blasting in salt mines.

There are many other explosives, such as rend rock, fulgurite, Vulcan asbestos, mica, Atlas and Ætna powders, which contain nitroglycerine, but they are not of as much importance as the ones just mentioned. Their chief difference is in the nature of the absorbent. The immense strides which have been taken in the improvement of high explosives have made many and great changes in various engineering enterprises. But perhaps the greatest development and application of high explosives has taken place in military tactics. Their simplest application in warfare is in connection with torpedoes, since within the same bulk a much more efficient substance than gunpowder can be obtained and with ordinary care there is very little danger of premature explosion by reason of accidental shocks. A useful explosive for military use should fulfil the following conditions: 1. It should be very shattering in its effects; 2. Insensible to shocks of projectiles; 3. Plastic; 4. Easy and safe to manipulate; 5. Great stability at all natural temperatures and in wet localities; 6. Easy to insert a fuse. Neither blasting gelatine nor dynamite fulfils all these conditions, but they satisfy many of them and besides are more powerful than other substances. For a long time attention has

been turned toward the firing of high explosives in shells, but it is only within late years that results have been obtained which are claimed to be satisfactory. Dynamite was the first agent employed. When fired in ordinary shells the charge was small and was no better in its effects than ordinary gunpowder, and when the charge was increased there was great danger of bursting the gun. And then again the detonating nature of high explosives breaks the shell into a great number of very small pieces and does not distribute them to as great a distance as when the shell is burst into larger pieces by the slow-burning and heaving gunpowder. There is a great difference of opinion as to which is the more efficient and destructive. The Austrians claim to have an explosive that will answer all the requirements. It is called Ecrastite and is supposed to be blasting gelatine combined with ammonium sulphate or chloride. They make many claims as to the qualities and properties of Ecrastite, but Commander F. M. Barber, U. S. N., in his paper delivered before the Franklin Institute, February, 1891, points out that there are many weak points in their claims. Probably no one has as yet invented an explosive that can be used efficiently as a bursting charge in a shell.

There is another field for high explosives, which is the introduction of huge torpedo shells which do not rely for their efficiency upon the dispersion of the shell, but upon the devastating force of the bursting charge itself upon everything within the radius of its explosive effects. The nitroglycerine compounds are not as well adapted for this work as melenite and guncotton.

In conclusion I would state that in giving the properties of the nitroglycerine compounds too much attention may have been given to their qualification and too little attention to the demerits which every explosive has. Guncotton and several of the dinitrobenzine class of explosives compare favorably with the nitroglycerine compounds.

ALBAN EAVENSON.

WROUGHT IRON COMPRESSION MEMBERS.

BY HENRY S. PRICHARD, ASSISTANT ENGINEER IN CHARGE OF THE DRAUGHTING ROOM OF THE NEW JERSEY STEEL AND IRON COMPANY.

This article is intended for those who are familiar with the calculation of stresses and the laws of statics, but who have not had experience in designing.

Compression members are designated as columns, struts and posts, and in certain structures by their position in the structure, as for instance the top chords in bridges. Column is the term used for a verticle compression member supporting a load, and is generally applied to building work. Post is applied to a vertical or inclined member, generally in a truss or trestle. Strut is the name applied to compression members whose strain is obtained from the secondary pressures to which the structure is subjected, such as wind, vibration, etc., and not from those loads whose support is the main purpose of the structure. In ordinary use these terms are to some extent interchangeable. Having given the strain, the first thing to determine is the form of the compression member. To determine this several things must be considered, among the most important being the nature of the load and the manner of its application, the unsupported length of the column as compared with its radius of gyration, the distribution of the metal as regards stiffness and the relative cost of the material and workmanship for various shapes. The first point discussed as regards its effect on the form of the member is the nature of the load, and the manner of its application. Live loads, especially if they come on suddenly and at frequent intervals, require a stiffer member than dead loads. Loads are applied in various ways, by pins, by riveted connection plates, by bearing on top of the member, or on brackets from its side, and by being riveted to the sides of the member.

It is desirable that the loads should be applied at the centre of gravity of the member, but it is not always possible to do this, and in those cases allowance should be made by increasing the area and the depth of the member in the direction in which it would deflect from eccentricity. This should also be done for

members subjected to side wind pressure, and horizontal or inclined members supporting their own weight as a beam.

The amount of extra metal necessary for eccentricity or for loads supported as a beam can be calculated fairly well for pin-ended members, but for members whose ends are fixed this is usually determined by judgment aided by approximate calculations.

For economical distribution of metal it is desirable that the liability of the column to fail by buckling should be equal in all directions. This is not always accomplished when the radius of gyration is the same about any axis, as the unsupported distance in one direction may be greater than in another, and in the case of pin connections the member has less stiffness about the axis parallel to the pin than about one at right angles to it, if the radius is the same about each axis. For pin connections the box shape is generally the best, as it admits of close packing on the pin. It should be wide enough to admit such pieces as are packed inside to have a proper clearance. The amount of this clearance depends largely on judgment, but for most cases one-eighth inch for each eyebar and one-quarter for each stiff member should be allowed. The member should be deep enough to admit the eyebar heads with about one-quarter inch clearance. It may seem folly to call attention to simple facts as to the width and depth of the member as regards connecting pieces, but the writer has frequently found that they have been neglected by designers.

When a member receives its load from simple contact it is often best to choose its form with reference to the distribution of the load over the member and in case of loads from beams riveted into the sides of the member, with reference to a simple and stiff connection, even though by so doing the metal is not distributed so as to give the greatest radius of gyration.

The second point is the unsupported length of the column as compared with its radius of gyration. The best distribution of metal to resist buckling in any given direction is that in which the radius of gyration about an axis at right angles to that direction is the greatest consistent with good construction. The importance of arranging the metal for a large radius of gyration, as compared with other considerations, depends largely on the length

of the member. If it is short and the load great the influence of the radius of gyration on the amount of metal required will be small, while in long members with light loads the obtaining of a proper ratio between the length and radius may become the principal factor in determining the size and shape of the member.

What the limiting ratio should be depends on the nature of the loads, the connections and the position of the member. For suddenly applied loads it should be less than for static loads, for pin connections less than for fixed connections, and for horizontal and inclined members, which have bending strains from their own weight, less than for vertical members. Many specifications provide that no compression member shall have an unsupported length exceeding 45 times its width.

The third point is the proper distribution of metal as regards stiffness. This involves the arrangement of metal as regards radius of gyration, proper thickness of metal and the connections between the different parts of the member. The form should be chosen with due consideration to the nature of the connections and unsupported length in different directions, so that the member may have nearly the same resistance to buckling in one direction as another. The proper thickness of metal and the connections between the different parts of the member are discussed further on for different kinds of columns. A fault in design to be guarded against is the spreading of the metal out too thin for the sake of getting a larger radius of gyration.

The fourth and last point is the relative cost of the material and workmanship for various shapes.

The various shapes of iron ordinarily used in making compression members differ in price per pound; angles and plates being the cheapest, and beams and columns being the dearest. The workmanship also varies for different kinds of members, so it often happens that the most economical member, for a given case, is not the lightest one, and may have an excess of stiffness in some directions as compared with others.

Having decided on the shape of the member, the next step is to find the area required to resist the strain.

The coëfficients used for compression vary from 6,000 to 20,000 pounds per square inch, according to the judgment of the

engineer and the nature of the loads. Eight thousand pounds for live loads and 16,000 for dead represent a fair average. Numerous formulas, founded partly on experiment, partly on theory and partly on judgment, have been devised for reducing these coefficients for the different ratios of length to the radius of gyration, but as experiments on columns are numerous and literature on the subject abundant it will not be discussed here. But attention is called to the fact that the student should not expect the results obtained in the formulas in some of the recent bridge specifications to agree proportionately with the results of experiments for various lengths of members, as they are founded largely on the judgment of engineers as to what should be used for the special cases and kinds of loading for which they are intended.

The formulas most in use are:

For both ends fixed, $S = \dfrac{a}{1 + \dfrac{l^2}{36{,}000\, g^2}}$

For one pin end, $S = \dfrac{a}{1 + \dfrac{l^2}{24{,}000\, g^2}}$

For two pin ends, $S = \dfrac{a}{1 + \dfrac{l^2}{18{,}000\, g^2}}$

Where a = allowed strain for compression.
S = allowable working stress per square inch.
l = length of member in inches, centre to centre of connections.
g = least radius of gyration of section in inches.

The results given by these formulas agree fairly well with experiments, and with proper coëfficients for compression are safe for members of ordinary lengths, but for long columns, say for those where $\dfrac{l}{r}$ exceeds 100, it is best to use smaller values for S than given by the formulas, as in practice the conditions are not generally as favorable as in the experiments on which the formulas are founded.

To find the area required, a given area must be assumed and its radius of gyration calculated or taken from tables and the area then tested by the proper formula.

Various shapes and combinations of shapes are used for compression members. If the member is short and the strain light, single pieces are often used. The following is a discussion of the use of the usual shapes as compression members.

Flats are only used for very short members and light strains in lattice girders, brackets, etc.

Single angles are used as posts for towers, as struts in wind and vibration bracing, and occasionally, when the strains are light, in roof and other structural work. This shape is cheap and its connections easily made. As a post for light rectangular towers it can be readily used without any eccentricity of strain and is well adapted to making connections with the bracing. In many places where it is used it has the disadvantage of an eccentric connection. When used in pairs it makes for most purposes a better compression member. Tees generally make better compression members than single angles, but as they are more expensive and their connections more difficult a pair of angles is generally used as a substitute. Single channels are not much used as they are unsymmetrical and weak in the direction of their width as compared with their depth. As beams are symmetrical and the disproportion between width and depth less than in channels, they make better compression members and can be used to advantage where greater stiffness is needed in one direction than in another. Both rolled beams and channels are expensive shapes and in compression-built members are often used for the larger sizes.

A knowledge of the usual practice in rivet spacing is necessary to properly design built members. The practice is not entirely uniform and may differ slightly in some places from the figures given in the following table:

DIAM. OF RIVET.	*H*	*A*	*B*	*C*
$\frac{7}{8}$	$1\frac{7}{16}$	$1\frac{1}{8}$	$1\frac{3}{4}$	1
$\frac{3}{4}$	$1\frac{1}{4}$	1	$1\frac{1}{2}$	$\frac{7}{8}$
$\frac{5}{8}$	1	$\frac{7}{8}$	$1\frac{1}{4}$	$\frac{11}{16}$
$\frac{1}{2}$	$\frac{13}{16}$	$\frac{13}{16}$	1	$\frac{5}{8}$

In which

H is the diameter of the rivet head.

A is the minimum distance from the centre of the rivet to the nearest surface, or projection of any kind, needed to drive the rivet by machine.

B, the usual allowance from a sheared edge to the centre of rivet in the line of the strain.

C, the minimum distance from the centre of rivet to a rolled edge at right angles to the direction of the strain.

Where possible A and C should be greater than given in the table.

The values of C are for punched holes, and drilled holes can be closer to the edge.

Most specifications provide that the pitch of rivets shall not be less than three diameters of the rivet, nor more than sixteen times the thinnest outside plate. These limits are fixed from considerations of good practice. Rivets can be driven closer together than three diameters, the actual limit being two diameters plus one-eighth of an inch. Such close spacing is undesirable and should not be used for important connections. For a member in compression it is not customary to make any deductions from the area of cross-section on account of rivet holes, as the rivets are supposed to completely fill the holes. The holes do, however, weaken the members to some extent. The coëfficients for rivets should be for bearing about one and a half times, and for single shear about three-fourths of the allowed compression. There are many forms for built compression members and a few of the common are here discussed.

Phœnix columns are described and illustrated fully in the Phœnix Iron Company's pocket book. They have great stiffness as compared with other columns of equal area of cross-section, are pleasing in appearance and are easily built. They are used to some extent in bridge work, but principally in buildings. Many engineers object to their use in bridges because after erection the inside of the column is inaccessible for painting and their end connections are generally made by simple contact on cast iron connection pieces.

Compression members composed of Z bars are sometimes used for posts in bridges, but are better suited for trestles and columns in buildings. They are built with a central web plate, to which are riveted four Z bars, or lattice bars may take the place of the web. The flanges which connect to the web should be placed close together with merely a good working clearance between them; for instance, if the flanges are 2½ inches each, the web should be about 6 inches, or if for some special purpose the flanges are spaced some distance apart, then batten plates should connect the outside flanges, spaced apart about eight times the least width of the member, to make the member sufficiently rigid. The least radius of gyration is small as compared with some columns of equal cross-sectional area, but so little work is required to build them and the connections are so simple that Z bar columns are extensively used.

Box columns are made channels, either rolled or built of plates and angles, connected together by either plates or lattice bars.

They are sometimes constructed with the flanges turned in, but more often with them turned out, as the riveting is much easier and can be done by machine. If the flanges are turned in, the space between them should not be less than two inches to admit of riveting. Box columns are suited to a greater number of cases and are more generally used than any other column.

In bridges the usual arrangement is to have the channels of the top chords and end posts connected by a plate on top and lattice underneath, while the intermediate posts are composed of two channels latticed. Columns for buildings generally have the channels connected by lattice, or by two plates forming a closed column. The proportions for lattice bars used in box, Z bar and other columns can not be calculated. In a perfectly homogeneous column with straight sides there would be no buckling, and the lattice would be in compression with a maximum intensity of less than that of the columns. If, however, from any cause, such as eccentricity or side pressure, a deflection does exist in the same plane as the lattice, then the tendency is to put some of the lattice bars in tension and some in compression in like manner to a lattice girder. A consideration of this fact, together with the experiments on columns, forms a basis for judgment.

Cooper's specifications require of lattice bars that "they must not be less than 2 x ¼ inches for posts 6 inches wide, nor 4 x ⅜ inches for posts 15 inches wide. They shall be inclined at angles of not less than 60° to the axis of the member. The pitch of latticing must not exceed the width of the channel plus 9 inches."

Pennsylvania Railroad requirements are, "single lattice straps shall have a thickness of not less than one-fortieth, and double straps connected by a rivet at the intersection of not less than one-sixtieth of the distance between the rivets connecting them to the compression members; and their width shall be:

For	15 and	12	inch channels or equivalent built section	(⅞ in. rivets)	2½ in.
"	"	"	" " " " "	(¾ " ")	2¼ "
"	10	9	" " " " "	(¾ " ")	2¼ "
"	8	6	" " " " "	(¾ " ")	2 "
"	8	6	(extra light sections) and 5 in. channels	(⅝ " ")	1¾ "

The distance between the connections of the strapping shall be such that the individual members composing the column, considered with hinged ends and a length equal to the distance between the connection, shall be stronger than the column as a whole; and in no case shall this distance exceed eight times the least width of these members."

The writer suggests the following: The lattice shall be so spaced that each channel between lattice connections shall be stronger than the column considered as a whole, and their size shall be obtained by treating the column as a lattice girder loaded at the middle with a load equal to three per cent. of the total compression on the column. Latticed columns should have batten plates at each end to bind the parts rigidly together. Their length is generally made from one to one and a half times the width of the member, according to the judgment of the engineer.

Compression members should be so designed that the different parts between supports should be as strong as the column as a whole. To accomplish this most specifications limit the thickness of channel webs to one-thirtieth and of cover plates to from one-thirtieth to one-fortieth of the unsupported width.

In members with forked ends each fork should, when calculated as a column of twice the length of the fork, have a strength sufficient for its share of the stress.

In some kinds of connections the stress is distributed over the entire section at the connection, but more often it is communicated to only a portion of the member. In such cases the stress per square inch on the bearing surface should not be over about one and a half times the coëfficient of allowed compression for the member as a whole, and the different parts should be so connected that each part will receive its share of the stress in a short distance from the connection. The surface in contact, as for instance in pier connections, is often so small that it is necessary to reinforce the member at the connection, and this reinforcing should be arranged as symmetrically as possible with regard to the parts reinforced.

In bridges the different members frequently receive their stress by simple contact with adjacent members and have connection plates, whose purpose is simply to hold the members in position. In such cases the surfaces in contact should be finished to have an even bearing. In columns such as are used in architectural work the top and bottom of the column should be finished so as to give an even bearing before riveting on the cap and base plates.

As far as possible the substance resting on top of the column and the substance on which the column rests should be arranged to come directly over and under the main section of the column and the cap and base plates should be of such size and distributing capacity that the stress on the bearing surface of both the column and adjacent substance should not be in excess.

Before leaving the subject, attention is called to two points. The first is the importance of making the centre of gravity lines coincide with the stress lines or of making proper allowance for a departure therefrom.

The second is to avoid a mistake often made of using angles too small to admit of proper riveting at points of connection. The writer does not expect by this discussion to enable any one to design work without practical experience, but hopes to call attention to the importance of devoting time and thought to details and to help the novice gain experience from practical work.

STUDENT LIFE IN HUNGARY.

A pretty poor theme for an essay, if we remember the interesting life of the German or even American students; their own separate world; their own pleasures and sports, and make comparison with them. But it becomes exceedingly rich if we are interested in the general customs, manner of living, and culture of the Hungarian people. The student life differs very little from the general life in that country. The "University citizen" enjoys himself in the same way as the other citizen does; beats the billiard ball, is engaged in politics, rebels like the rest.

Politics is the especial weakness of the students, and I may say that they make almost as much of a sport of it as the American students do of foot-ball. Both have fighting as their fundamental principle. Yet I think brain developing political polemics, rebellions for true principles, are more proper for a student than the ambition of the American student with a score-card in his hand.

The great multitude of the Hungarian students are animated with ideas of freedom and justice, and contend for the principles of the extreme left of our Parliament. It is hard to understand that the majority of these hottest enthusiasts become later the most loyal mamelukes.

These displays of the political opinion of the students may take a serious form, as was proved two years ago when the youths of the country became roused against the Germanizing bill of the Government, referring to the examinations of the volunteers. The rebellion became so dangerous that the Chief Secretary of the State almost lost his life. Although he succeeded in saving it, he lost his popularity, which fact caused his fall soon after. The students were driven from the University by bayonets, their parks transformed into streets, and on these streets, by the decree of the omnipotent chief-of-police, not more than two persons were allowed to be together.

No doubt this enthusiasm of the Hungarian college boys in the interest of free ideas has a very beneficial effect upon the whole

nation, and as the love of freedom is inoculated into the blood of the Magyar, he honors its standard bearers. This is just where the students of the Hungarians differ from those of other nations. The American student, for instance, is cool to the interests of his country or his fellow citizens; he looks only after his own welfare, and though he is sometimes an excellent grinding machine, he does not play any part in society. Quite different is the case with the Hungarian. From the moment when the "rektor" (equivalent to the American president) shakes his hand and declares him a "University citizen," he becomes another man. He is regarded as the pride and intellectual future of his country, has admission to the best circles, and is gladly received everywhere. The freedom which he imbibes from the methods of University teaching fills his soul; the form in which the sciences are dished up before him makes him enthusiastic for everything fair and good. And just this noble, free atmosphere which the University citizen brings into society is that which makes him interesting in society, which is exhausted by numberless injustices, illegalities, and dissimulations.

The Hungarian student does not abuse the good will and respect of society, for his whole ambition appears in the effort to maintain his place in it. That in this effort study is sometimes neglected, is natural. But studying does not go on there in the same way as at American Universities. Bureaucracy and pedantry do not play any part; no grinding-machines will be developed, but men, possessing a healthy, logical order of thought. Most of the subjects will be given in the form of lectures, and as taking notes is difficult, one has to apply himself to follow the train of thought.

This system, where the audience remains really an audience, sharpens much better the faculties of mind than the childish recitation system.

Only three times a year does the student appear at the blackboard and undergo a verbal "colloquium." It is easily seen that in such freedom one must have a strong feeling of duty to keep himself upon the level. In fact, these Universities were not built for children, who must be constantly forced to study; they are for men with independent will-power.

The chief distinction between German (or in still higher degree American) and Hungarian Universities is that the latter lack totally the idea of equality. However incredible it may seem after what has been said, it is a very true and pitiable fact that caste spirit rages there in full measure, making intimate contact between the students and the forming of " Burschenschafts " or fraternities impossible. It is in the nature of the Hungarian to stick to his traditions, and very reluctantly does he form new ties of true friendship. This reserve is characteristic in all University matters. The professors are officially " Right Honorable Sirs" and they have very little contact with the students. Each of them is a full-bred philosopher in his branch, and they receive high honors from the Court as well as from the nation.

The students are scarcely acquainted with each other. Here is a count sitting, there a baron, the father of this fellow is a delegate, of that one, a shoemaker. Contact between such different elements is impossible—in Hungary.

Only the self-cultivating societies, scientific and literary clubs, bring the students slightly together, and these exist in great numbers. True ambition is the force which leads them in these societies: they are the preparatory schools of life.

The literary work is very lively in these clubs, and the interest of the public in their receptions is immense. This is especially true of the universities of law, which exist in the greatest number, and are best attended.

The noble talent of declamation is strongly cultivated, because readiness of speech is an inborn quality of the Hungarians. The diseased desire of public appearance, the celebration fever, is the natural consequence of this property, and these maladies are diffused there in the same degree as here in America. But this weakness appears there on a nobler ground than here, and does not reach the excesses which characterize the "parades" and "meetings" of this country, a ridiculous parody.

The celebrations of the Hungarian students where they appear "in corpore" are mostly on the historical holidays of the nation. On "All Saints'" they put crowns on the graves of the great literary and political dead, and hold declamations over the dear ashes.

The 15th of March is the chief holiday of the students. In the year 1848, on this day, was declared the independence and freedom of the nation; on this day stood Petőfi, the poet of the people, before the nation, and with it swore, by the God of Magyars, that they would not be further prisoners. The whole mass of students, on this anniversary, march to the animating sounds of the "Ràkoczy March" played by the brown "czigany fellows," to the statue of Petőfi on the shore of the Donau, where one of the student orators, in full Hungarian parade dress, lays a crown at the feet of the poet, and declaims the same powerful poem of Petőfi which on the same day awoke the nation from its long sleep. That Kossuth and the members of the Independent Party on the one hand, and those of the Government Party on the other, participate in this celebration, it is almost superfluous to mention.

Celebrations in the University are only at the opening. The whole faculty appears then in parade dress, high spurred boots, a fur mantle with golden couplets thrown on the shoulders, sword on the side with the golden handle in the hand. Generally a secretary of the state or his representative is present, and the celebration begins with the speech of the last year's "rektor," who recounts the results gained during his presidency. This is followed by the speech of the new "rektor," and the year opens with great enthusiasm. I should mention that this celebration is not held in any church, and that the college is not connected with any particular religious sect. Even in law academies, some of which are kept up by the Catholic clergy, nobody will be pressed to church work.

As I mentioned above, the students are recognized in the best circles. The balls given by the students every year are the most select and the grandest of the season, and are always visited by members of the court.

One of the characteristics of the Hungarian college boy, which at once distinguishes him from German and American students, is his silk hat. To the passions of the Magyar college boy belongs first the theatre, which, regarding the didactic and noble directions of our stage, is a passion honest enough. Besides this he cultivates a passion for billiards, and not seldom for cards. In beer or wine drinking he does not show any extraordinary talent. He

likes banqueting and can not be surpassed in genial toastmaking, but this is a national property in Hungary. "Class suppers" do not exist among the students, as they are wanting in the least class feeling either in the form of sympathy or hatred.

This description has been taken mostly from the life of the students of Buda Pesth, who play, no doubt, the most prominent part in Hungarian student history. They may be taken as a general type of the Hungarian students, only local or historical facts making somewhat different the students of different universities.

The number of colleges is not very great. Only two universities exist where all the branches of science are taught; one in Buda Pesth, the other in Klausenburg. But these are immense buildings with separate law, medical and technical branches, fitted up for thousands of students. They are under the management of the government, the professors being regarded as government officers. In spite of this, tuition fees are high, which fact can probably find its explanation in the costly equipments of the institutions and the avowed purpose of checking the number of applicants. For the poorer students there are several "stipendia" and prices for literary work. Beside these two great universities, there are a great number of law academies, in Kaschau, Erlau, Sarospatak, etc., kept up mostly by powerful Catholic religious orders or Reformed Churches, under the control of the government.

The profession of law is the most general profession in Hungary and most of the magnates even obtain their education for the Legislature and other high duties in law schools.

Hungary being an agricultural state, the technical branches can not develop to such a high degree as in other countries. Only in the last decade has the nation perceived the importance of these branches and begun to cultivate them.

Our Polytechnicum in Buda Pesth is now a model institution. All the scientific schools of Hungary are in rapid progress and growth. On account of the common fever, the eagerness for scientific learning has been very acute there in the last few years, in spite of the strictest precautions of the government, which make the life of the student harder with every day.

Andrew Pintér.

In dealing briefly with a subject so vast as the articulating telephone has grown to be, the more important points only can be touched upon. No other invention has ever attracted so much attention, so soon sprung into universal use, nor was so speedily brought toward perfection, as the telephone. It is now indispensable to the needs and comfort of mankind.

A few words in regard to the inventor of the telephone may be of interest. Who was he? Scientific men by no means agree upon an answer to this question. Public opinion and the Patent Office have awarded to Alexander Graham Bell the honor of the invention; but it was conceded by the United States Supreme Court at Washington during the great telephone controversies that there were electric telephones in practical operation years before Bell conceived the idea of talking over a wire.*

In 1854, Charles Bourseul, a Parisian, published an accurate description of a magneto telephone, such as was afterwards invented by Bell, but he constructed no instruments.

Philipp Ries, of Friedrichsdorf, Germany, in 1861 made many successful experiments with musical electric telegraphs, and it is to him we are indebted for the term "telephone." When properly adjusted—perhaps accidentally—his instrument would transmit certain words, but never with sufficient reliability to be of practical use.

Very singularly, on the same day that Mr. Bell filed the application for his patent, Feb. 14, 1876, Mr. Elisha Gray, of Chicago, applied for a caveat for an electric speaking telephone. Bell's patent was granted March 7, but, strange to say, up to that time he had not succeeded in transmitting one articulate word through his telephone.

Ten years before this patent was granted, in a little country town in Cumberland County, Pa., four miles from Harrisburg, Daniel Drawbaugh, an inventor and machinist, had constructed an electric telephone and operated a line between his shop and house. Poor, and failing to excite in his unscientific neighbors

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* See the opinion of the Court delivered by Chief Justice Waite, in the U. S. Reports of the Supreme Court, No. 126, October Term, 1887.

an interest in his "talking machine," as he termed it, he did not possess the means to patent it. More than two hundred witnesses have sworn to the fact that they saw, talked through, or knew of "Dan Drawbaugh's talking machine" about the year 1870.*

Hosts of others have laid claim to priority in the invention of the telephone, with more or less hope of success in the courts, but, whatever may be the claims of other inventors, to Bell certainly belongs the credit of first introducing to the world the greatest achievement of the nineteenth century. That he should have been allowed the sole right to manufacture the instrument is manifestly unjust to the public, who are compelled to pay most exorbitant rentals, from which the Bell monopoly has grown fabulously wealthy.

Though in daily use all over the world, many of the principles of its construction and practical application are but imperfectly known. The Bell telephone consists of the instrument now used

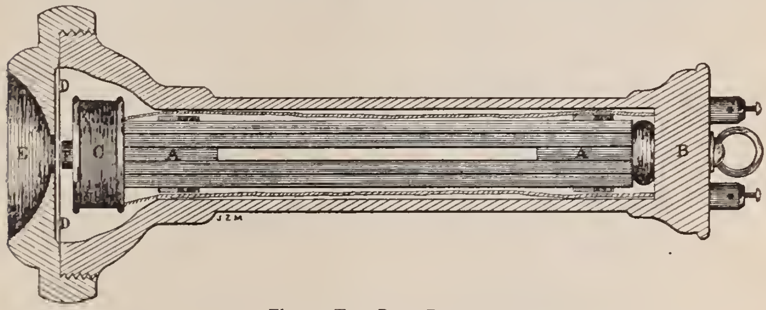

Fig. 1.—THE BELL RECEIVER.

A Compound bar magnet.
B Hard rubber case.
C Coil of No. 35 copper wire.
D Diaphragm of ferrotype iron.
E Mouthpiece.
F Soft iron core of coil.

only as the receiver, or ear piece. At first a battery and soft iron cores were employed, but it was soon discovered that permanent magnets would answer as well. As now manufactured for commercial purposes, the magnet is compounded of four bars made of black diamond steel, each $4\frac{1}{2} \times \frac{5}{8} \times \frac{1}{8}$ inches, and will lift three times its own weight. The core of soft iron fixed at the the end is $\frac{17}{64}$ inches in diameter, and is surrounded by a coil of No. 35 silk wrapped copper wire with a resistance of 75 ohms.

* See Scientific American Supplement No. 437, May 17, 1884; also U. S. Supreme Court Reports, No. 126.

The diaphragm is of soft Russia iron, .008 to .012 inches thick (ferrotype iron), cut $2\frac{15}{64}$ inches in diameter, and when mounted is .015 inches distant from the end of the core of the magnet. Fig. 1 shows a section of the Bell receiver now used. A pair of these telephones can be used to hold conversation over a hundred miles of wire under favorable circumstances, the same instrument serving as transmitter and receiver. They are termed *magneto* telephones, as they depend upon vibrations of sound to furnish the current, by the oscillation of the diaphragm, which acts as the armature of the magnet, in front of the pole.

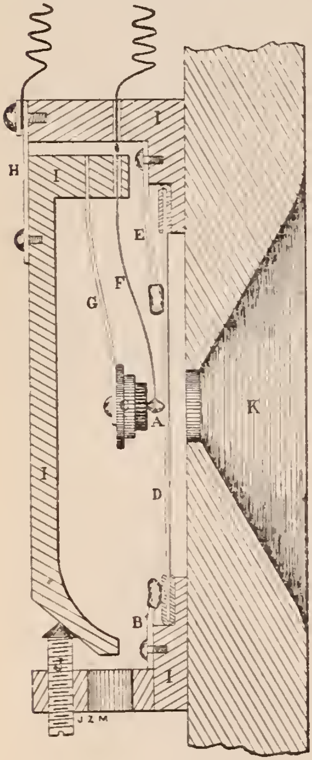

Fig. 2.—THE BLAKE TRANSMITTER.

A Platinum button. *F* Platinum spring.
B Clip spring. *G* Carbon spring.
C Carbon button. *H* Frame spring.
D Diaphragm. *I* Iron frame.
E Dampening spring. *J* Adjusting screw.
K Mouthpiece in box.

A point that is not generally understood and erroneously stated in the elementary physics is, that electrical impulses sent over the wire by the advance and recession of the transmitting diaphragm are not reconverted into sound by a *molar* motion of the receiving diaphragm, but by a *molecular* motion only. In other words, the transmitting diaphragm moves, the receiving diaphragm does not.

The art of telephony would have been greatly limited had there been no other than the magneto instrument. In 1878 Thomas A. Edison, who had long been experimenting with the telephone, applied the principle discovered by himself in 1873, that varying the pressure on carbon varies the electrical resistance, to his carbon telephone. Various modifications were soon made, of which the Blake transmitter was adopted and used by the Bell Company. Fig. 2 illustrates the essential parts of this instrument in section.

The course of the current is as follows: Entering through the conductor at the upper left hand side, it

goes through the frame to the "carbon spring," thence through the carbon and platinum buttons, and out the "platinum spring," which is insulated from the iron frame. The microphonic action takes place between A and C, the system being operated by vibrations of D. The diaphragm is held in place by the springs B and E, and is dampened by a rubber band around its edge, and rubber over the ends of the springs. The adjustment of the instrument is effected by regulating the tension of the spring G by means of the screw J.

For the operation of the carbon instrument a battery is indispensable. All forms of carbon telephones are classed under the head of *microphone transmitters*. Since a battery, and not the voice, is relied upon to furnish the power for sending the electrical impulses, the instrument should not be shouted into; to speak clearly and distinctly is all that is necessary. This form of instrument will transmit sound to a much greater distance than the magneto telephone.

The long-distance telephones are carbon transmitters of the *granular* type. The iron tympanum, which receives the vibrations of the voice, conveys them to a little brass box through a second (mica) tympanum. This box has two carbon terminals, separated by a space of .068 inches, which is loosely filled with grains of carbon the size of very small gunpowder. The imperfect electrical contact between these grains forms the microphonic action. This instrument, known as the "solid back," is being manufactured by the Bell Company to replace the long-distance transmitters now in use, being of simpler construction and greater durability. The induction coil is of invaluable aid to the microphone transmitter. The primary coil is connected with the instrument in the local battery circuit, and the secondary placed in the line circuit, as shown in Fig. 3. The variations of resistance in the carbon telephone being very small, they would be but a very small factor in a line of great resistance; but in the primary circuit of an induction coil they are an important factor, and influence the secondary current so that much better results are obtained in articulation and long-distance speaking. The coil used in a Blake transmitter has a resistance of .75 ohms in the primary circuit, and 250 ohms in the secondary. Contrary

to expectation, the resistance of the secondary circuit of the induction coil used with the long-distance telephone, found by experiment to give the best results, is very small, only 14 ohms.

No sooner were the inventions of Bell, Edison and Hughes made known than hundreds of scientists and mechanics set to work to make modifications of the telephone, some of which were great improvements. New principles of action were discovered. Bell himself succeeded in talking along a ray of light with his radiaphone, making use of the electrical property possessed by solenium, of changing its resistance with the light thrown upon it. Mr. Chichester Bell invented a water-jet telephone in which the vibrations of the diaphraghm altered the resistance in a jet of water constantly kept in the circuit. Mr. Gray changed the electrical resistance of the circuit in his instrument by vibrating a platinum electrode in a conducting liquid near a similar point forming the other electrode. All microphones will serve as transmitters when properly adjusted. M. Bréguet invented a mercury telephone which acts without a battery. A globule of mercury set into vibration by the voice generates sufficient electromotive force to reproduce a similar motion in a globule at the other end of the line. Mr. Preece constructed a thermo telephone receiver in which the vibrating current heated with each pulsation a fine stretched wire, which immediately cooled and contracted, and this, when attached to a diaphraghm, reproduced the sounds made in the transmitter.

Edison and Dolbear devised condensing telephones, which are nothing more than electric condensers made in a convenient form. The air vibrations vary the static charge on the plates of the condenser, and the receiver at the other end, similarly affected, reproduces the sound. One terminal is all that is required with the Dolbear receiver.

Without any attempt at arrangement of parts, Fig. 3 plainly illustrates the electrical connections of transmitter, receiver, call bell and magneto machine in a telephone instrument. When the telephone is not in use the connections are as represented in the figure, only the bell being in the circuit. To call up, the button *E* is pressed, throwing in the magneto *A*. Unhooking the receiver *H* operates the switch *F*, and the transmitter and receiver are

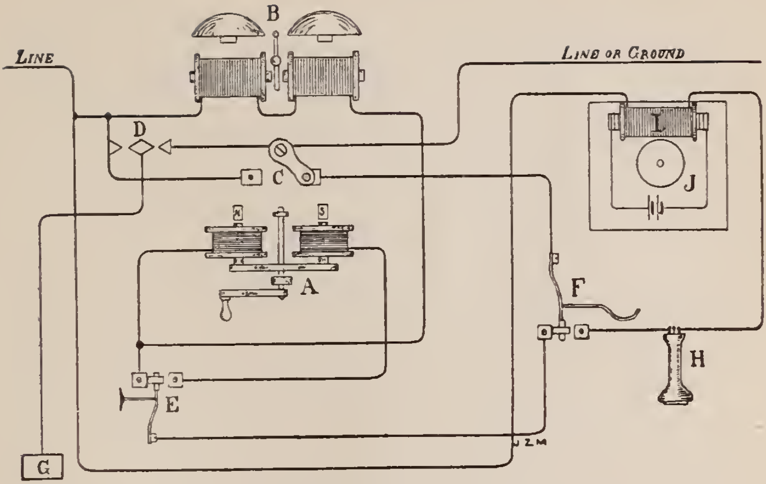

Fig. 3.—CONNECTIONS IN A TELEPHONE INSTRUMENT.

A Magneto Call.
B Electric bells.
C Main switch.
D Lightning arrester.
E Button switch.
F Hook switch.
G Grounded line.
H Bell receiver.
I Induction Coil.
J Transmitter.

in the circuit and ready for operation. The switch *C* is for the purpose of cutting out the instrument, as in case of storms. At *D* is a lightning arrester arranged to ground a charge coming in over either line.

Almost as numerous as the modifications of the instrument itself are the systems of exchange. In this country the American Bell Telephone Company's system is used almost exclusively, but in some cities the Law exchange is still employed. In France the Lartigue-Brown System is the most extensive, and is one of the most complete in the world. The Swiss system is modeled after the American exchanges, but differs in some points.

All who have used the telephone are familiar with the annoying frying noises and "cross-talk." These are the result of induction from other telephone or electric lines. Usually the ground is used for the return circuit, but these troublesome interferences are to a great measure overcome by the use of a metallic circuit.

The problem of long-distance telephony does not so much involve the construction of instruments as the conductors employed. There is no doubt but that it would be entirely possible to hold

a conversation between any parts of the globe, using the instruments we now have, if a full metallic, well insulated circuit of heavy copper wire were used. The greatest distance that has been spoken over is said to be 2,500 miles, across France and Russia. The Long Distance Telephone Company in this country are accomplishing wonders over their lines.

Many very interesting experiments may be performed with the telephone. Using the magneto instrument, the writer has heard conversation very distinctly through the resistance of the hand, no battery being used. The perspective in sound may be plainly observed by the use of two telephones. For instance, by fixing a transmitter at each side of a stage, and listening at a distant station to an opera, the relative positions of different actors may be readily judged from the sound. It has been computed that a Bell telephone transmits .000555 of the energy imparted to the diaphragm, and throws out .000,000,666 of the original sound. Thus the extreme delicacy of the human ear is plainly illustrated.

In constructing telephones the desideratum is to reproduce sound in pitch, loudness and quality. In many of the microphone transmitters clearness is sacrificed to loudness. The quality of sound enables one to recognize the speaker or the nature of the noise.

The art of telephony has by no means been perfected. There is every reason to believe that it will in time supplant the telegraph. It is safe to say that in a very few years the telephone will become as indespensable to the convenience of the household, office and shop as illuminating gas is in our buildings to-day.

JOHN ZOLLINGER MILLER.

ON A SONGSTRESS.

O maiden, when thy glorious notes
  In throbbing pulse of song arise,
My raptured spirit from me floats,
  And wings its way to Paradise.

But when mine eye, with mute amaze,
  Surveys thy beauty's perfect store,
My soaring heart its passage stays,
  And sighs for Paradise no more.

EDITORIALS.

WE announce the election of Messrs. J. Y. Bassell, Jr., F. A. Coleman, C. K. Shelby, P. H. Smith, L. W. Walker and C. W. Gearhart to THE QUARTERLY Board.

THE FOOT-BALL SITUATION.

THE frequent outbreaks of temper, caused by the supposed opposition of a certain university to a pet plan of ours, is liable to defer the fulfilment of that end. There are times when we must be aggressive, but it is not now. We must conciliate. Nothing will be lost, our purpose is the same, the end more certain.

A university is but a little state, we, the citizens and our managers, the envoys. While the ministers of history play for larger stakes, their ability to attain an end is the measure of their greatness; so we must display no hostile spirit when such a show will render a negotiation futile. We need not lose sight of our end in the mean time. Persistent zeal will always be recognized and it is ever better than bluster that seeks to crush, but which may raise insurmountable obstacles.

The best way out of the present situation is to be aggressive in the field, make more good records and then apply again. If we we have in the mean time made no sworn enemies by our unwise display of "spirit," we certainly are sure of a more cordial reception. A score, and a score only, is what will win over the opposition. A fact is worth a shipload of argument.

THE ELECTIVE SYSTEM.

LEHIGH is not encumbered with the elective system. The curriculum is fixed and final. Its fairness has been questioned by some few who want to take special courses and obtain a degree. However well we may argue with ourselves that we need electives, it is seldom we come across anything so absolutely bitter in opposition to them. "Woe to that policy, so popular in certain quarters, that comes to the relief of intellectual laziness. The modern device of elective studies in our colleges

is largely a concession to the distaste of students, not for this study or that, but for *hard* study. Nothing is more ludicrous than the spectacle of a college Freshman or Sophomore hunting in his catalogue for studies fitted to the peculiar bent of his genius. The phrase 'bent of genius' or 'natural aptitude' is a pack-horse for an infinite deal of laziness. It is supposed to be a reverent way of holding God responsible for a shirk. Do we not know as we know the sunlight that, in the elective system, those studies are selected that are accounted the *easiest*, and that thereby a premium is placed upon mental indolence? Do we not know that in the majority of instances those studies which are evaded are the *very ones* required to tighten 'the loose screws,' and give a rounded completeness to the students' manhood?"

In the face of all this, we venture to assert that we do need electives at Lehigh. As long as the rosters are called in, and it is required that the roster meet the approval of those in authority, it is to be doubted if the Special will be able to pursue an aimless course fashioned for ease and "intellectual laziness;" but if he chooses what he requires and is made to do the work he is better satisfied than if obliged to be an unwilling student in a branch he does not want, but is compelled to take in order to be eligible for a degree. Especially would such a system be of value in the higher classes, for, having chosen his intended branch of activity, it is but fair that extra time shall be given to its pursuit.

THE EPITOME.

THROUGH the courtesy of the Board of Editors, advance sheets of the '92 *Epitome* have been placed in my hands. The book is a handsome volume of 274 pages, the largest *Epitome* ever published. In the way of illustrations it contains three excellent artotypes; the first, a collection of beautiful views of the campus, which forms the frontispiece; the second, a faithful likeness of Dr. Chandler, which accompanies a short sketch of his life, and the third, a scene in the foot-ball game between the University of Pennsylvania and Lehigh, Nov. 22, 1890.

Besides these, there are half-tones from photographs of nine groups, the athletic teams, musical organizations, etc. The artistic work is for the most part good.

Among the new features which deserve creditable mention is the short summary following the name of each member of the Faculty, showing his connection with various scientific and other organizations. The snap-shot of "Jim Meyers" will call to the mind of many an alumnus the good old yarns and incidents of the janitor's room. The college record of the Seniors as printed in the class list is a compliment to '91 which she will no doubt highly appreciate.

The records of the book are quite complete and betoken an enormous amount of work in their compilation and verification. Athletics occupy much space in this department. The Senior and Junior Historians have endeavored to get out of the time-worn style of bravado in their histories, and their work is consequently more readable.

The literary matter in the book swells its size considerably. The prose articles are interesting, but to call the other matter poetry, except in a few instances, would be a gross misnomer. Without any intent to dampen admiration for the book, we regret that the editors have allowed some of this trash to appear, and we hope to see the time when published matter at Lehigh shall not call down ridicule from readers who may not have the gentle consideration for the authors which must be shown by local critics in this case.

The book is with few exceptions well arranged. Typographical errors are almost altogether absent and the few evidences of carelessness will be pardoned. Unfortunately for the appearance of the volume, the head lines which so set off each page of last year's *Epitome* have not been retained. The board has been compelled to make the price of the book $1.00, an order of things not likely to command popular approval; but this course has been rendered necessary because of the lack of support the *Epitome* receives from college men.

The college annual should be in the hands of college men because it is here the only complete "epitome" of college life for the year, and every man with the proper spirit will provide himself with at least one copy of the '92 annual.

WAIFS AND STRAYS.

"LIKE a tale that is told." And when the tale is finished we learn that the hero and heroine were married and lived happily ever after. The indefiniteness of of the phrase is its chief charm. It is like the blue haze of the distant mountain which a single distinct line will destroy. We don't want to know that things ran smoothly for a year or two and that then the baby got the measles, and the beefsteak fell into bad habits and grew tougher every day. We don't want to know anything about the petty domestic jars and misfortunes, even if we are assured that the baby recovered eventually and the beefsteak reformed. It is enough for the simple historian of the heart to give a roseate glimpse into the happy meadows to which marriage is the gate, and all beyond is left to the more or less vivid imagination of the reader.

And now that the tale of our life (this is for the Seniors) is nearly finished, let us not destroy the idyl of the past four years with too practical a finale. We will have to become stern and practical soon enough, goodness knows! Let us idealize for the few moments we have left. Why should we talk too much of $1000 a year and board, or, more likely, $40 a month without? Why should we say that Jones has a fine position in Timbuctoo, and Brown is going to teach in Bath? They have courted their Clio or Urania, and now that they have wedded the profession of their choice, why seek to pry too closely into the arcana of the Future? Let us end our life here like the simple folk tale: "They all lived happily ever after." And the editor sees no reason why we should not, so long as we go through life in the same way, taking care of the present and not investigating too closely the rosiness of the sunset, resting assured that the golden gate of the morrow will lead to a happy To-day.

Four years is, after all, a very minute portion of one's life, yet how much may be compressed into it. And that part of a man's existence bounded by entrance examinations and graduation is without doubt the fullest and richest of all. "Four years ago," as the Senior historians always say with commendable unanimity, "we met upon the campus, the finest class that ever entered Lehigh's gates." And then with brilliant powers of self-glorification they proceed in the orthodox way to proclaim their greatness. Perhaps it is not the best possible taste, but it goes to prove that even after four years of mingled pain and pleasure there are many lingering regrets that all is over. How many men, with their diplomas in their hands and a couple of magic letters tacked to their names, would have been glad to give it all up and start at the beginning again to taste the variegated experiences of Bethlehem life? Once more to stammer forth "*non paratus*" or sit down with the glowing consciousness of a well-earned ten,—once more to simmer for a couple hours on the bleachers, and to wander home over the campus through the lengthening shadows,—once more to linger over a book or paper in quiet of the Library, or to see a Freshman perform some marvelous feat in the Gym.,—in short, to do once more everything we have done, and on a new and improved plan? "How much harder we would study," they say, "and how much better times we would have." It is well that they can not do as they would, the disappointment would be so great. There is a time for everything. The time to enjoy Freshman frivolity is when one is a Freshman, the time to want it all over again is the day after commencement, and the time to honor the fair name of Lehigh is from now on, forever.

ORIGINAL, AND GOOD.

THE IDEAL.

"Not the treasures is it that have awakened in me so unspeakable a desire, but the Blue Flower is what I long to behold."—*Novalis.*

Something I may not win attracts me ever—
Something elusive, yet supremely fair;
Thrills me with gladness, yet contents me never,
Fills me with sadness, yet forbids despair.

It blossoms just beyond the paths I follow,
It shines beyond the farthest stars I see:
It echoes faint from ocean caverns hollow,
And from the land of dreams it beckons me.

It calls, and all my best, with joyful feeling,
Essays to reach it as I make reply;
I feel its sweetness o'er my spirit stealing,
Yet know ere I attain it I must die!

—*Florence Earle Coates, in the Atlantic for May.*

ON THE LIBRARY STEPS.

Dark 'gainst the sun-stained glory of the west
The bare trees stretch their mute, beseeching arms;
Impetuously regardless of its charms,
With interwoven limbs they do their best
To hide its beauty from the careless quest.
But all tbeir wild confusion never harms
The ruddy sky; despite their vain alarms
It shines forth by the contrast doubly blest.

COLLEGE COMMUNISM.

AS a rule, college boys are not very selfish. At least most of them are improvident, and that is very often synonymous with being generous. And, forsooth, this is the reason that college boys invariably despise selfishness; for this very fact there is a strong tendency toward communism.

Now there are different kinds of communism. There is what might be called *physical* communism. Philosophers like Sir Thomas More and Bacon and Mr. Bellamy have consumed much valuable time and many quires of paper in expounding their theories on physical communism. We frequently see good illustrations of this phase of communism.

When a fellow leaves a base-ball in my room, I thank the gods for all their gifts, and pray that the owner may not soon bethink him to come to my room for his property, and I put the base-ball in the darkest corner. Again, we leave our doors unlocked, being aware that our friends will enter, lounge upon our furniture, smoke our tobacco, and use our stationery, or whatever happens to suit their fancy.

We straightway go and do likewise in another fellow's room. This spirit extends even to our washer-ladies. Everything that leaves my room in a clothes-bag I part with tenderly, and whatever may return I welcome as a gift.

Then there is *mental* communism. Now, the value of a commodity, we are told, depends on the quantity thereof in market and the difficulty of procuring. It is here that one great objection to our mental communism arises. The dearth of ideas in examination hall is very sore—distressingly so. I know not whether it be because of the general atmosphere of the place, but certain it is that the famine is felt by all, and the value of ideas after the papers have been passed round rises enormously. Truly, unselfishness is a very noble thing, but, like Thanksgiving turkey, it may be taken in excess; and very valuable articles of thought should neither be given away too recklessly nor received too freely.

Lastly, there is *moral* communism. College morality, as such, is very rare. But if such a thing be found, surely it is much too valuable to lose, and if it be too valuable to lose, it is much too valuable to borrow. I can pardon a man's wearing a borrowed overcoat, but for a man to appear clothed in some one else's morality is a sin which can not be exaggerated.

Then there is a specious kind of morality, which, like political money, passes current among us, but which, if its intrinsic worth were appreciated, would be a drug upon the market.

When a college man has done, or is about to do, a thing whereof he is ashamed, he tries to find some phrase or sentiment which will justify his action, at least in his own eyes. Failing to find in himself the necessary narcotic for his conscience, he forthwith seeks some friend whose more fertile imagination or more inventive genius may furnish him with the moral drug his spirit craves. So we share our faults, our pretexts and our excuses, as well as our property and our ideas; so that mass of precedent has grown up, that mountain of college custom, college sentiment, college theory, which we hold in common, which controls our college lives, and which constitutes for us a substitute for the code of morals which exists elsewhere.—*Nassau Lit.*

FOR LEHIGH MEN.

THE EVOLUTION OF THE EPITOME.

The development of our annual is an excellent example of the theory held by disciples of LeConte, on the origin of the human species. The 70-page pamphlet which first bore the name *Epitome* was issued by 'Seventy-eight in what might be called the Eocene days of Lehigh's geology. All that precede "may be regarded as anticipations."

The few remaining fossils of the book show that, as far as size and development go, it was indeed an insignificant Eohippus compared with the fat and well groomed annual of recent times. But we must not carry our figure too far. Considering ornamental features and volume, we can certainly make more of a showing than our predecessors. But there is very little evidence in the literary contents of the first numbers to show that a 'prentice hand brought them forth. Quite the contrary. The brawn has vastly increased with the years, but the brain exhibited in the early *Epito-*

mes disproves the evolution theory completely. If it were not for the name, we would fain allow ourselves a sigh for the good old days and the genius of former *Epitome* editors.

The '78 *Epitome* was edited by H. J. F. Porter, M. P. Paret and F. P. Howe. Its mission is shown by the following paragraph from the editor's salutatory: "And now, among this list of honorable (college) publications, our modest little *Epitome* for the first time asks a place. It does not claim to be a literary production, that is not its genus. The causes that have led to its birth demand of it that it shall be simply an honest exponent of all our college organizations, and this, kind reader, is all that we have sought to make it." The salutatory ends by "Commending to succeeding classes the tender sprout planted by the hands of '78." An honest exponent of college organizations was, indeed, the only title the first two *Epitomes* could lay claim to. But the difficulties that had to be overcome make the honor of originating the book sufficient glory for its editors. From the lists of societies, clubs, athletic teams, and records, the only departure was a silhouette showing a youth with an abnormally developed brain. He stands near an immense telescope. In the distance is seen approaching a turtle, who bears a rather tipsy looking building supposed to be the future gymnasium. Underneath is inscribed:

"Our heads are full, our brains fatigued
With cycloids and trapezium;
So now to get our muscle up
Pray give us a gymnasium."

The *Epitome* of '80 contains more of the work of the artist. A picture of our old friend, Mr. Rice, heading a surveying party, called the "chain gang," is especially good.

The first sustained attempt at verse appears in the '82 book. It is a very good attempt, too, relating how

"A number to the Doctor's room were called,
To have their crimes completely overhauled."

Lee was accused of getting tight on a certain evening. He was frightened into pleading guilty to the charge, of which he was really innocent. The Doctor and his associates considered this a good joke. Then two more were brought in.

"To them was charged, that when in open boat
They made some wicked plans to wet the coat
Of the instructor, who, as they had tried
To make a survey of the river's side,
Had gone along to aid them in their work.
From this grave charge not either one did shirk,
But bore it bravely, and put in this plea,
That they were unawares (O, pshaw!) that he
Was standing up, nor did they mean to jump
Out from the boat together, and thus dump
Him, by the rocking of the craft."

The book had quite an elaborately decorated cover and must have rather taken the shine off previous numbers. It commemorates the death of Asa Packer, which occurred that year. The editors were C. C. Hopkins, J. W. Reno and J. D. Ruff.

The '83 annual is remarkable for "good gags." Among them is the following dialogue between Mr. Rice and Geo. F. Duck, '83, later an instructor himself.

Mr. R. "Mr. Duck, you have very little on the board."

Mr. D. "Oh no, Mr. Rice, I have a good deal."

Mr. R. "Well, perhaps you have, for you."

Another dialogue has a student ask Mr. Rice how to project a sphere. He replies: "We will not disturb the spheres at present, Mr. J."

'84's *Epitome* contains a college idyl in Hiawatha meter, and marks the rise of a long since forgotten literary society, founded by Messrs. Wong and Whang, one of whom soon after went to Lafayette, and the other back to China.

The next number was considerably larger, containing 92 pages of reading matter; and, what was doubtless much more to the point, 21 pages of "ads." The illustrations were made mostly by H. W. Rowley and show considerable artistic taste. The number on the board had swelled to seven, Tolman, Rowley, Birney, Cooke, Zimmele, Snyder and Wilbur. The well written salutatory contains the words, "The long promised gymnasium stands nearly finished before our eyes." The athletic boom of the preceding year, however, (when Lehigh came next to Columbia and Harvard in field sports) had collapsed. Among the poems in this number is a short epic, which begins thus:

"Sing a song of Lehigh,
Of new instructors merry.
They did get a little room
Near the Seminary."

"And there was a window
Right across the way.
What a funny chance that was
You at once will say."

* * * *

"But unto the racket
Tumbled Blick one day.
And no more the maidens
Look across the way."

We have all noticed those whitened window panes. They have not been transparent since that day. A very laughable account (clothed in scriptural language) of the effect of the smallpox epidemic in South Bethlehem also appears. It says of the students: "And they were of two parties. And the one were believers on external prevention, but the others on internal prevention. And those of the first party brought forth rubber coats, and even gowns called dusters, for they said, 'We will array ourselves in these garments, that if a germ strike us, having no foothold, it may not endure and *will* fall by the wayside, and we shall be safe.' But the most were of the second party, and they said: 'Go to! ye are fools. We will drink soda with many flies in it, and lemonade, of which the most part is stick, and the pestilence will not harm us. For we *are* tough.'"

The editorship was taken that year from the Sophomore and given to the Junior class, so the next number was also called the '85 *Epitome*. The feature of this book was the illustrating by Kenneth Frazier. The athletic cut by him is, I think, the most artistic design which has appeared in our annual. The book was now taking a form more like the annuals of to-day. It had the board cover, steel engravings of class and fraternity cuts, and was printed on heavy paper. The labor of the business manager was rewarded with 38 pages of advertisements. A fabulous account of a foot-ball

game between Lehigh and Bishopthorpe contains the interesting item that "Dicky" (Dick Davis, of course) was hurt, and carried off on the lace handkerchief of the captain of the Bishopthorpe team.

The '86 board went back for the last time to the paper cover. It produced a very good specimen though. We can judge of the literary excellence when we know that Richard Davis, M. A. DeWolf Howe, Jr., and Wm. P. Taylor were on the board. The gags on each other by the editors are very amusing. One tells of the new course introduced at Lehigh, called the "Davis Special Course." With the '87 *Epitome* nearly all trace of the former characteristics disappears. It is recent. It belongs to our age, we may say. It is the same in order, family and species with the best of those that have followed it.

NOTES.

This column will contain, chiefly, such information in regard to addresses and occupations of Alumni as does not appear in the latest issue of the *Lehigh Register*. Please contribute.

'78. M. P. Paret, C.E., present address, St. Simon's Mills, Ga.

'78. H. F. J. Porter, M.E., Superintendent Braddock Wire Co., Pittsburg, Pa.

'86. L. J. H. Grossart, C. E., City Engineer of Allentown, Pa., since May 19, 1891.

'86. The Chief Engineer's office of the Lehigh Valley Railroad is about to be located in South Bethlehem. The address of S. J. Harwi, C.E., '86, C. J. Parker, C.E., '88, and J. W. Boyd will be hereafter South Bethlehem, instead of Mauch Chunk.

'87. Kenneth Frazier, B.A., has three pictures on exhibition in the Paris Salon of this year.

'89. C. H. Deans, C.E., Engineer for Sooysmith & Co., Fort White, Fla.

'89. George W. Harris, B.S., Chemist for Sooysmith & Co., Fort White, Fla.

'89. John J. Martin, M.E., Engineer in charge of Thirtieth Avenue Cable Road, New York City.

'90. C. H. Detwiller, with Levering & Garnague, Iron Bridge Manufacturers, Philadelphia.

'90. W. V. Kulp, C.E., with the Brooklyn Elevated Railroad, 31 Sands St., Brooklyn, N. Y.

'90. Alexander Potter, C.E., Stanwix Engineering Co., Rome, N. Y.

'91. Eric Doolittle, C. E., Assistant City Engineer, Bradford, McKean Co., Pa.

'91. J. S. Griggs, M.E., with Wm. S. Sellers & Co., Tool Manufacturers, 1600 Hamilton Street, Philadelphia.

PERIODICAL AND BOOK NOTES.

[A continuation of the list published on page 59 of Vol. I, No. 1, of THE QUARTERLY.]

KEY TO ABBREVIATIONS OF NAMES OF PERIODICALS.

TITLES.	WHERE PUBLISHED.	ABBREVIATIONS.
American Journal of Philology.	Baltimore.	Am. Jour. Phil.
Blackwood's Edinburgh Magazine.	Edinburgh.	Blackwood's Mag.
Century Illustrated Monthly Magazine, The	New York.	Cent. Mag.
Journal of the Association of Engineering Societies.	Chicago.	Jour. Ass'n Eng. Soc.
Journal of the Royal Microscopical Society.	London.	Jour. Roy. Micro. Soc.
Journal of the Society of Arts.	London.	Jour. Soc. Arts.
Lancet, The	London.	Lancet.
Nature.	London.	Nature.
North American Review.	New York.	N. Am. R.
Quarterly Review, The	London.	Quar. R.
Scribner's Magazine.	New York.	Scribner's Mag.

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Alabama Coal Fields. Eng. Min. Jour., May 9.

Allotropic Silver. L. E. and D. Phil. Mag., Apr., p. 323.

Aluminium, Advantages of. Am. Eng., No. 13.

Analysis of Brandies and Alcohols, General Method for the. Jour. Anal. and Ap. Chem., Apr., p. 231.

Apparatus for Gas Analysis. Jour. Anal. and Ap. Chem., Mch.

Apparatus for Heating Substances in Glass Tubes under Pressure, An. Jour. Frank. Inst., May, p. 388.

Aqueduct, New Croton. Proc. Eng. C. of Phil., May, p. 325.

Arches, Repairing Wet. R. R. Eng. Jour., No. 5, p. 238.

Armature Bores, Graphic Method of Analyzing Losses in. Elec. World, May 9, p. 342.

Artesian Well Practice in the Western States (cont'd IV). Eng. News, Apr. 4.

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Atomic Weights, A Proper Standard for. Chem. News, No. 1039, p. 193.

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Benzine and Related Hydrocarbons, The Constitution of. Am. Chem. Jour., Apr., p. 279.

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Boilers, The Application of Lime in. Am. Eng., Apr. 18.

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Bricks for Street Paving and their Manufacture. Eng. News, Apr. 4.

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China, Railways and Collieries of North. Iron, No. 954.

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Cinder, Varieties of Tap. Iron, No. 954.

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Columbite of the Black Hills. Am. Jour. Sci., May, p. 403.

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BOOK REVIEWS.

[Books, or Periodicals, which are to be reviewed or indexed, should be addressed to THE LEHIGH QUARTERLY, South Bethlehem, Pa.]

LIGHTNING, THUNDER AND LIGHTNING CONDUCTORS. BY GERALD MOLLOY, D.D., D.Sc. NO. 139 OF THE HUMBOLDT LIBRARY OF SCIENCE. (THE HUMBOLDT PUBLISHING COMPANY, 28 LAFAYETTE PLACE, NEW YORK.)

This pamphlet presents the latest theories in regard to lightning and electricity, as held by the most prominent authorities. It is written in a pleasing style and in language simple enough for the understanding of the uninitiated. Thirteen cuts illustrate the pages. The historical and general information contained in it help to make it interesting.

WHAT IS MUSIC? BY ISAAC L. RICE. NO. 140, HUMBOLDT LIBRARY OF SCIENCE.

"The *resume* of the various theories current in ancient times" with which the author prefaces the views of the modern scientists includes those of the Chinese, the Hindoos, the Egyptians, and the Grecians. The author concludes by presenting his own views on the subject. The treatise will be interesting both to the physicist and the musician.

MINERAL PHYSIOLOGY AND PHYSIOGRAPHY. A SECOND SERIES OF CHEMICAL AND GEOLOGICAL ESSAYS BY T. STERRY HUNT, M.A., LL.D., (SECOND EDITION. SCIENTIFIC PUBLISHING CO., NEW YORK, 1891. PRICE, $5.00.)

The position occupied by this noted man in the scientific world is guarantee enough of the value and usefulness of this volume, which consists of eleven essays written at different times but following a fixed plan. They are all subjects which can not fail to interest any one possessing a liking for either geology or mineralogy.

In essay number five he discusses the many conflicting theories regarding the origin of the crystalline rocks. The seventh throws new light on a subject which has received little attention, the decay of crystalline rocks.

The student in mineralogy will be particularly interested in the eighth essay, which not only gives a history of the various systems of classification, but gives very fully the author's classification, " which is at the same time chemical and natural historical."

The tenth essay on the geological history of serpentines in North America and Europe can not but be valuable.